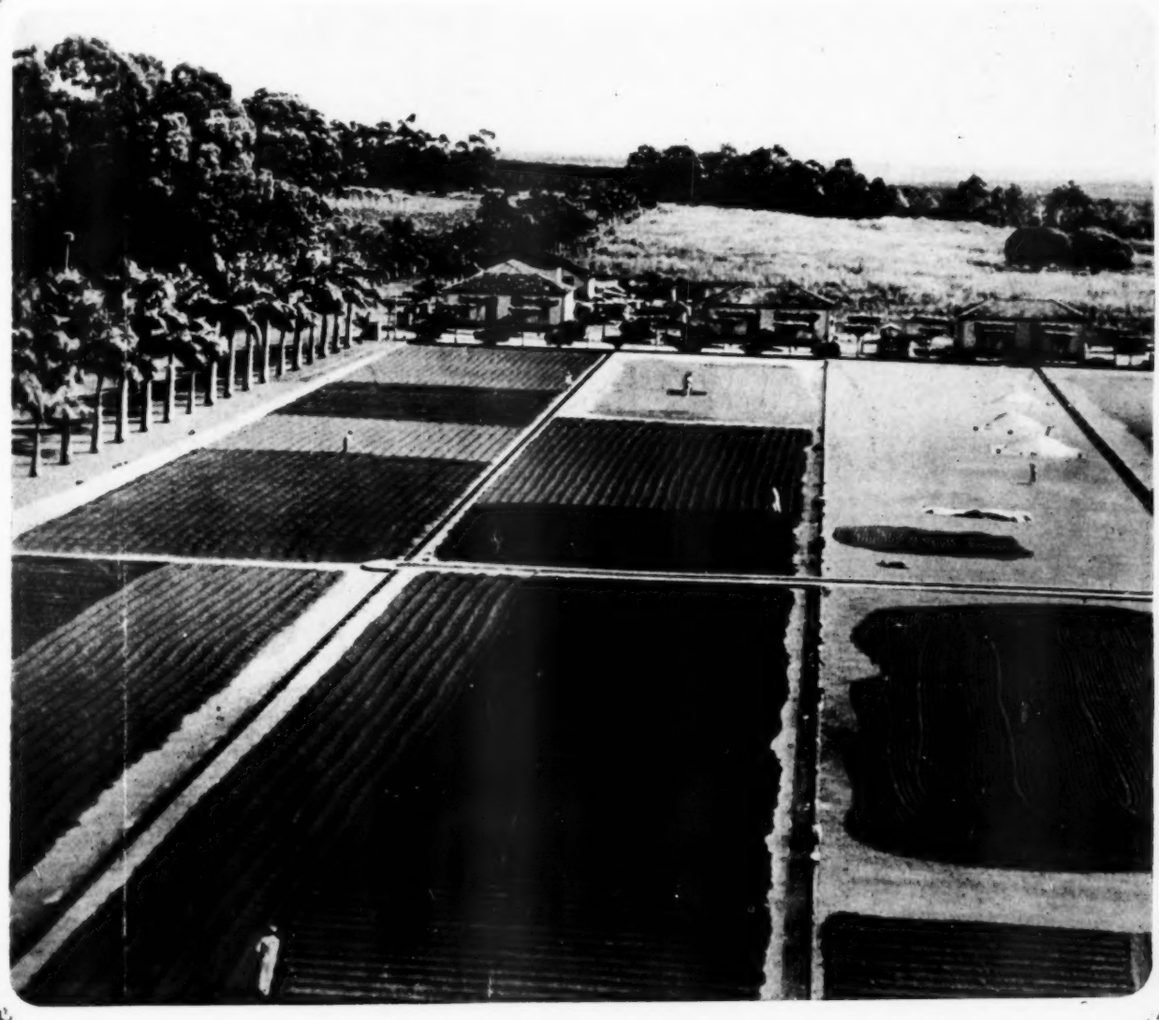
WORLD CROPS

THEIR CULTIVATION, PROTECTION, STORAGE, HANDLING AND PROCESSING FOR FOOD, FODDER, AND INDUSTRIAL PRODUCTS



VOLUME 2, No. 5 MAY 1950

A Publication of The Leonard Hill Technical Group

Pipe Lines to plenty

CHEMICAL ENGINEERING MEETS SHORTAGE OF WORLD CROPS

The peoples of the world are short of food and of other products grown on the land. One of the causes of the shortage is the relentless impoverishment of the soil of its plant nutrients. Another frequent cause is inefficient processing of field crops. For instance, for every 4 pounds of cottonseed oil extracted, almost 1 pound of oil is lost during pressing. Time is ripe for new installations producing more fertilisers; for machines extracting more vegetable oils; and for a lot of other equipment serving a score of farm chemurgic industries. Bamag Limited design, engineer, ship, erect and start up complete installations. Write now for leaflet "When planning Complete Chemical Plant" showing how all over the world our plants are forming a vital link in the "Pipeline to plenty".

BAMAG LIMITED

The Chemical Engineers for Complete Installations

Rickett Street, London, S.W.6. 'Phone: Fulham 7761.
EXPORT SERVICE: 60 Buckingham Palace Road, London, S.W.1.
Cables: BAMAG, LONDON.

31/1

WORLD CROPS

Editor: Sir Harold A. Tempany, C.M.G., C.B.E., D.SC., F.R.I.C.

CONTENTS

VOL. 2 No. 5 MAY 1950

EDITORIAL COMMENT:
Crops Without Soil; Cloves in Zanzibar; The Annual Price Review; Chemotherapy and Plant Disease; The Future of the Tractor and of the Farm Animal; Man-made Weather; Crop Protection Panel 185

The Control of Cocoa Diseases in West Africa—*R. A. E. Galley*, PH.D., A.R.C.S., D.I.C., F.R.I.C. 189

Place of Research in Increasing Labour Production 193

Antibiotics and Plant Protection—*Erna Grossbard*, B.SC. 194

The Clove Industry of the Zanzibar Protectorate: Part II—*R. O. Williams*, O.B.E. 198

Fertilisers and Grassland Production 201

Pest Infestation Research Covers Wide Field 204

The Olive Industry in France and North Africa—*P. Bonnet* 205

Protection of Orchards from Frosts 208

The Sugar Cane—*A. C. Barnes*, C.M.G. 211

Land Use and Conservation in Japan—*C. L. W. Swanson* 215

Sesame: Potentialities of an Ancient Oil Seed Crop under Modern Conditions—*A. E. Haarer*, F.L.S. 218

Mounted Implements on the Farm—*A. B. Lees* 222

Correspondence 224

Farm Machinery; New Forage Harvester; Australian Tractor Plant's Output; Robot Screen for Compost-Making; French Equipment Scheme 225

New Books 226

Agriculture in Fiji 227

World Crop Reports 229

THIS MONTH'S COVER

A coffee drying ground in Brazil. Here the beans are spread on concrete floors after washing and fermentation and exposed to the sun. The drying period may last from 15 to 20 days or even longer, during which time the beans acquire uniform colour.

(Photo: Brazilian Government Trade Bureau)

Price per copy 2s. 6d. *Subscription rates on application*

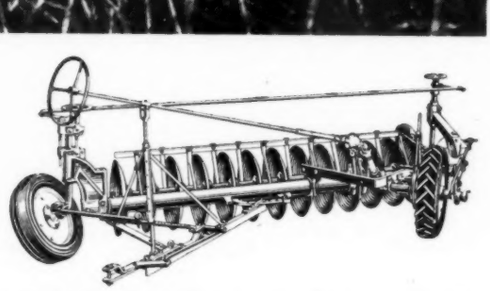
LEONARD HILL LIMITED, 17 STRATFORD PLACE, LONDON W.1, ENGLAND (Mayfair 7383)

MASSEY-HARRIS

744 D TRACTOR AND ONE-WAY DISC

now available from the Sterling area

For primary cultivation no other outfit offers the speed and economy of the Massey-Harris No. 744 Diesel tractor with 6-ft. One-way Disc. Under normal conditions 20 to 25 acres can be ploughed at depths down to 7". Designed to leave trash on top of the ground to prevent soil erosion, the One-way Disc makes a level top seed bed without ridges or dead furrows and is ruggedly built to stand the hard shocks of breaking up new land.



The Massey-Harris No. 509 One-way Disc has the exclusive roto-lift feature—the discs only, and not the frame, are lifted, thus saving power and eliminating wear of the power lift mechanism.

MASSEY-HARRIS LIMITED *Pioneers of Farm Mechanisation* **LONDON · MANCHESTER · KILMARNOCK**

ENQUIRIES TO:—MASSEY-HARRIS LIMITED, 11 PALL MALL, LONDON S.W.1

Editorial Comment

Crops without soil

TO most people the idea of crops without soil at once suggests hydroponics or tank cultivation; indeed, in the last 20 years a good many prophets have predicted the decline of soil cropping and the rise of nutrient solution cropping. However, all practical evidence suggests that this method of growing plants is economically possible only where there is little soil or diseased soil or when expensive and luxury crops are being intensively cultivated. But to reach this conclusion does not put an end to the idea of food production without soil as the rooting medium. Rather more quietly than hydroponics, other soilless methods of producing foodstuffs are being developed. They are methods which can be operated in factories. And they are, at any rate in terms of scientific economy, much more efficient than any existing farm operation. Hydroponics merely altered the medium of rooting; it still used plants to produce food. These new methods reject crop plants as well. In any plans for trying to meet the food requirements of the world's expanding population, almost certain to rise from 2,000 to 3,000 millions by the year 2000, these methods of producing food without both normal crop plants and soil are bound to play a significant part. The farmers of the world should not ignore their probable introduction and development.

Food from yeasts and algae

First, there are fermentation processes, not unlike the methods for producing penicillin, by which cheap carbohydrate foods—often wastes such as molasses—may be bacterially converted into protein foodstuffs. A farmer, of course, converts carbohydrates and vegetable proteins into animal protein as milk and meat. But certain strains of bacteria, notably *Torulopsis* yeast, will perform a much more efficient conversion. Such a process was extensively operated in war-time Germany and has been operated in Jamaica from 1944. The protein foodstuff produced is a yeast, possibly much less attractive than bacon or steak, but exceedingly valuable where high-grade animal protein foods are grievously scarce. Perhaps of even greater potential significance is current work in Sweden, in which another yeast organism produces an oily fat from carbohydrate. It has recently been pointed out that a 1,000-lb. bullock produces 1 lb. of protein in 24 hr.; the same weight of *Torulopsis* yeast will produce 4,000 lb. of protein in the same time ! Under food scarcity conditions, when a yeast form of protein would be acceptable and could even be popularised, a factory would have a theoretical 4,000 : 1 advantage over a meat-producing farm. The farmer would still have a stake in the venture, for he would have to produce the necessary carbohydrate crops for conversion into yeast proteins.

Nor is this all. Crop plants obtain much of their substance and all of their energy from photosynthesis. As a converter of sunshine even a good farm is only about 0.3% efficient ! Single-cell fresh-water algæ utilise 2% of the sunshine that they receive. American scientists at the Stanford Research Institute have shown that one species of these cells can produce 44,000 lb. of protein per acre; compare this figure with the highest vegetable protein producer among farm crops, the soya bean, which yields 336 lb. of protein per acre. The American pilot-plant experiments have produced materials containing over 50% protein, or, by varying the culture conditions, materials containing as much as 85% fats. With this kind of culture the medium is merely a solution of mineral nutrients plus nitrate or ammonia forms of nitrogen. The products of algæ growth have already been used as poultry feeding stuffs.

It may be that, as world population expands, these methods will merely supplement existing farm methods rather than compete with them. This, indeed, is almost certain to be the case. But in areas where populations are huge and where soils are poor and limited significant adjustments to the farm cropping pattern may follow from the introduction of yeast and algæ methods of food production. Scientific advances in these fields are not reaching many headlines, but they are, nevertheless, proceeding rapidly and hopefully.

Cloves in Zanzibar

THIS and the preceding number of this journal contain an article on the clove industry of Zanzibar by Mr. R. O. Williams, while in this issue there also appears a review of Mr. G. E. Tidbury's recently published book on the clove tree. To the English reader cloves are familiar chiefly as a domestic spice and particularly as a flavouring ingredient of, for example, apple pies, but they are extensively used in the Far East, and particularly in Java, for making clove cigarettes, a peculiar usage, it seems, but doubtless satisfying to its devotees.

The clove tree is the mainstay of Zanzibar, where it has been the principal crop grown for the past 150 years; it is grown by traditional and somewhat crude methods on Arab- and African-owned plantations. Of late years it has been threatened by

Sudden Death disease and the control of this presents a serious problem to which a good deal of intensive research is being devoted. On its control the future of the Protectorate seems to be largely dependent. Incidentally, it presents another facet of the administrative problem of enforcing disease control measures among less highly developed planting communities, of which the plight of the cocoa industry in West Africa is at present the most striking example.

Improvement of the clove tree

Under the circumstances it seems curious that hitherto little attention has been paid to the improvement of the crop by introduction or evolution of better varieties. The tree is a native of the East Indies and in 1933 a mission from Zanzibar reported on its investigations of the clove industry in the East. One might reasonably have expected that the members of that mission would have been impressed by the desirability of collecting planting material of the different strains of clove growing in the countries they visited for trial and comparison with the stock under cultivation in Zanzibar. Had this been done it might have influenced the present position. Yet there is no evidence since the establishment of the industry of any attempt to produce a clove plant more suited to the local environment, more disease-resistant, or capable of higher yields. When one remembers the considerable improvements that have been effected by such measures in connection with other tropical crops—rubber, oil palms, rice, sugar, cane or cotton, for instance—the omission of similar work with cloves is striking.

Mr. Tidbury admits, in his book, that the clove tree in Zanzibar is living in a definitely adverse environment compared with its natural habitat; that the entire clove population of the Protectorate is derived from possibly only two or three trees, thereby limiting the genotypes and, in the absence of appreciable mutation, precluding the possibility of improvement of the stock by selection. He further admits that Penang cloves are definitely superior to those produced in other parts of the world. Yet there is no record of the importation into Zanzibar of stock for comparison with the local tree, or of investigations concerning the merits of varieties under cultivation elsewhere, or whether these differences are varietal or accountable for by soil and climate.

It seems evident that the clove tree in Zanzibar is in no way superior, and may well be inferior, to its ancestors of a century and a half ago. May it not be that the present trouble is in part attributable to the continued cultivation of a weakened stock in a definitely adverse environment? And might not work on imported new varieties on the one hand, or on the selection of desirable and prolific mother trees from existing stock on the other, give valuable results?

The annual price review

LAST month new farm prices, resulting from the annual review, came into effect after consultations between the Agriculture Ministers and the National Farmers' Unions of England and Wales, Scotland and Northern Ireland. This year farmers in the United Kingdom will receive further State assistance to the tune of approximately £7,000,000 in spite of the feeding stuffs subsidy being discontinued from April 1 and half the existing fertiliser subsidy being withdrawn from July 1.

For some, however, what is taken away with one official hand will be given back in good measure with the other. From July 1 schemes will operate to assist farmers in the purchase of fertilisers to be used for improving grassland and marginal land; grants will be paid for one-third of the actual expenditure on the purchase of fertilisers for leys, excluding one-year leys, up to 25s. an acre and a rate of two-thirds of the actual expenditure up to a maximum of £3 an acre will be paid for permanent pastures of at least seven years' standing.

Apropos of this news, a shortened account of a paper recently presented before the Fertiliser Society in London, which appears on another page of this issue, is of more than usual interest. The potentialities of judicious fertiliser application to grassland are tremendous and let us hope that the stimulus to be provided by the new scheme will show a response in the direction of fuller grassland utilisation.

Chemotherapy and plant disease

AN article in this issue of WORLD CROPS discusses the use of antibiotics for the control of the fungoid and bacterial diseases of crops. It is remarkable, as our contributor points out, that, although during the past two decades discoveries of profound importance have been made in the realm of insecticides and weed-killers, there have been comparatively small parallel developments in the treatment of fungoid and bacterial diseases, and we still continue to rely largely on the preparations of copper and sulphur which were standard 50 years ago. It is true that organo-mercurials have achieved success as seed dressings, while phenolic and cresylic preparations are used to treat some maladies, but in the fungicidal field so far there have been no spectacular developments similar to DDT, BHC or 2-4 D, for example.

The successes of penicillin and streptomycin as well as the sulphonamides in human and animal medicine naturally raise the question whether such developments are possible in crop husbandry. As our contributor points out, such potentialities are possessed by the antibiotics, but their practical application on a large scale still remains a matter for the future and many points will have to be

elucidated, particularly in the economic sphere.

On the more general aspect a point of some importance is that, while in human medicine bacteria are the predominating causal organisms, in the phytopathology of plants and crops fungal organisms occupy the chief place. Virus diseases, however, are assuming ever-growing importance and it must be admitted that both in human and plant pathology we are still awaiting the discovery which will provide the master key to their control.

Thus there is particular interest in the work of Horsfall and his colleagues at the Connecticut Experiment Station and other workers on chemotherapeutic substances. These substances, when absorbed by the plant, may inactivate viruses or prevent them from multiplying, and act on bacterial and fungal pathogens by direct toxic action or by inhibiting the formation of fungal toxins, or otherwise increasing the resistance of the plant.

The work is still in the initial stages, but in this field, as well as in that of antibiotics, there seems reason to hope that the future may hold important developments.

The future of the tractor . . .

IT is a far cry from the dim and distant time very early in this century when we attended one of the first competitions for agricultural tractors to be held in this country. It was a wet October day on a farm in Hertfordshire and a handful of farmers and other damp but interested people surveyed somewhat dubiously the not very efficient performances of about half a dozen rather primitive, and in some cases distinctively erratic, machines of divers shapes and size. Since then what a change. Today British farming proudly acclaims itself the most highly mechanised in the world. Manufacturing firms vie with one another in producing tractors of ever-increasing performance and efficiency; new uses and new attachments follow one another with bewildering rapidity; the machinery sections at agricultural shows occupy more and more space. The Smithfield Show in its post-war renascence has become the ' Smithfield Show and Agricultural Machinery Exhibition,' with tractors and other machinery occupying the centre of the stage.

Still more recently the Salon de Machine Agricole, held in Paris last February, claims to have been the largest show of agricultural machinery ever held under one roof. Among its 760 exhibitors were firms from the U.K., the U.S.A. and many European countries from both the front and the rear of the Iron Curtain, and even from the Argentine Republic. It appears to have been, in fact, a veritable apotheosis of mechanisation at which farmers of many nations met on common ground to criticise and admire the exhibits.

It may, and quite probably does, portend that in France and throughout Europe generally the rapid mechanisation of agriculture will follow the same trend as in Britain.

The tractor, with its numerous appendages and applications, has undoubtedly revolutionised agriculture and none can doubt that its role will continue to increase in importance as the years elapse; indeed, there are those who, in their enthusiasm, prophesy that in the foreseeable future the draft animal will, to all practical intents, have disappeared as a factor of importance in agriculture in the more developed countries. The horse, according to these prophets, will survive merely as an instrument for sport and recreation, a charming relic of a bygone age, while the patient tractive ox will become relegated to the limbo of things forgotten.

. . . and of the farm animal

With this dictum we cannot altogether agree; in our view the farm animal has, and will continue to have, a definite part to play in the farm economy for many years to come and, indeed, indefinitely. We think that this should be recognised and that the aim should be not the complete supersession of the draft animal by the tractor but recognition that the draft animal still has a part, though perhaps a more restricted one, to play in supplementing the work of the machine and that their roles are complementary, a sort of symbiosis, in fact.

Point is given to this reflection by a recent circular issued by the British Ministry of Agriculture, which views with some alarm the decline in the number of farm horses during the past decade; in the United Kingdom it has, in fact, fallen from 1,083,900 in 1939 to 617,000 in 1949. The circular goes on to point out that tractors have to depend on imported fuel oil, while the horse ' proceeds under its own steam generated by home-grown food.' Even assuming that adequate supplies of tractors, spare parts and fuel can be relied upon, there are still many occasions when the horse can be more suitably employed than the tractor.

Smaller farms with, say 100 to 125 acres of arable land possessing only one tractor will almost certainly require two horses at least.

The tractor is particularly valuable for getting heavy work done quickly (such as ploughing and cultivating after harvest and in the spring rush); for mowing and reaping also the tractor is advantageous; under certain conditions the extra soil consolidation given by the tractor is a great asset. But there are numerous light jobs about the farm which are more cheaply and efficiently done by horses, and in some conditions it may be preferable to carry out light cultivation by horses rather than by tractors, notably when conditions are wet owing to the lower compressive effect of the horse.

Under overseas conditions the same arguments apply with equal and even greater force. Particularly is this so in the more remote tropical areas where the difficulties and expense of providing tractors, spare parts, fuel and, above all, service are much greater than in regions nearer to centres of production. Moreover, in such conditions the value of the animal as a source of supply of organic manure has to be taken into account. To us it seems unlikely that in the tropics tractors can ever completely replace oxen, mules or horses.

It is not, of course, intended to suggest that the great extension of tractor cultivation under such conditions is not essential to progress; indeed, the tractor undoubtedly offers the most effective means of rapidly extending the cultivated area and economising labour. But it must be remembered that in many cases the prime requisite is to replace hand labour by machinery and that in certain circumstances, and for certain operations, animal traction may possess advantages. It is not really a question of competition between the animal and the tractor, but rather one of deciding the conditions under which each can be used to the best advantage. They are, in fact, complementary and not competitive.

Man-made weather

IT has always been the dream of the farmer that somehow he might be able to obtain some sort of control over the vagaries of the weather and so mitigate the effects of the droughts, floods, hurricanes and other manifestations, the fear of which have haunted him since agriculture began.

Since the beginning of time these phenomena have been looked upon traditionally as manifestations of the will of an inscrutable and all-powerful providence which must be accepted with due and proper submissiveness, the only alternative being, in the view of the more unsophisticated and optimistic, the propitiation of the supernatural authorities responsible for the inconvenient manner in which these things are ordered. Upon this belief the rainmaker and the witch doctor of more or less primitive peoples have battened through the ages in various guises and waxed fat in the process.

Let it not be supposed that we are as yet within measurable distance of controlling weather conditions on a major scale, but on the principle that the Lord helps those who help themselves mankind has already made some progress in mitigating the worst effects of some of them by cultural measures, including irrigation where it is possible. More recently he has been turning his attention to more subtle and yet more ingenious methods. The efforts, not yet, it is true, entirely crowned with success, of American and other scientists to induce precipitation by spraying ' dry ice ' on to clouds from aeroplanes is one example, while the claims of the Russians to be able to induce artificial thunderstorms of great intensity and violence by techniques of an undisclosed nature are another.

In more restricted fields the suggestion recently made in a paper read before the Royal Society of Arts by Mr. F. A. Secrett that it might be possible to imitate the effect of dew during the hours of night is intriguing, while equally so is the indication that by spraying a completely atomised veil of moisture in orchards it may be possible to avert or minimise the damage occasioned by spring frosts.

Particularly interesting are the recent efforts, described elsewhere in this issue, to provide protection against frost in orchards by the use of rotor fans which bring down the warm air from the upper inversion layer of air. The method has already given promising results in Australia and California and this season will be tried out on a larger scale by the National Institute of Agricultural Engineering working in conjunction with the authorities at Long Ashton and East Malling Research Stations.

These are, it is true, still but minor efforts to control meteorological conditions, but they are stimulating to the imagination. Who knows, with the advance of time and knowledge, whether ultimately mankind may not be able to secure a hitherto undreamed of degree of control over the fluctuating weather conditions, which since the world began have been the worry and perplexity of the cultivator?

Crop protection panel

THE announcement by the Society of Chemical Industry of the formation of a Crop Protection Panel in connection with the Agriculture Group of the Society is an event of considerable interest.

This development is a sequel to the Second International Congress of Crop Protection held in London last July, a report of which appeared in our issue of September 1949. It occurred to some of those who were present at the Congress that there was need for a scientific body in Great Britain which would be concerned with the problems—and particularly the chemical problems—involved in the protection of crops. The matter was brought to the notice of the Council of the Society and the formation of the Panel is the result.

The remarkable advances made during the last decade in the application of chemical science to the protection, not only of crops in the field, but also of stored crop products and livestock are certainly sufficient to warrant such a step and the new organisation should have plenty to discuss.

The inaugural meeting is being held at the Royal Institution on April 27, when Dr. Hubert Martin will deliver an address on 'Advances in Chemical Methods of Crop Protection.'

We believe that the new organisation should fill an important gap and we wish it every success.

The Control of Cocoa Diseases in West Africa

ROBERT A. E. GALLEY, Ph.D., A.R.C.S., D.I.C., F.R.I.C.

Agricultural Research Council

The major sources of trouble to the West African cocoa industry are the virus disease known as 'swollen shoot' and capsid bugs, which are a serious menace. At present the only practicable remedy for 'swollen shoot' is the drastic one of cutting out, but recent research indicates that other remedies may be possible, notably use of the new systemic insecticides.

An article in our issue for September 1949 discussed the threat to the industry from diseases and pests, and in this paper the author, who has recently visited West Africa, discusses the possibilities of new remedies.

SIR HAROLD TEMPANY, in his article entitled 'The Threatened Future of Cocoa,'[1] gave an interesting account of the development of cocoa in British West Africa. He indicated how, in the last 50 years, the rapid expansion of cocoa production there has resulted in a crop in 1948-49 of well over 400,000 tons, compared with less than 300,000 the previous year and an average of less than 400,000 tons for the years 1935-39. These figures, looked at alone, might give the impression that all was well with the crop, but this high yield must not be allowed to give a false sense of security about the West African cocoa position.

The reasons for the outstanding yield, as Tempany pointed out, were 'the result of a combination of favourable weather, the coming into bearing of large newly-planted areas and the bringing back into bearing of old neglected trees as a consequence of high prices.'

All is not well, however, with cocoa in West Africa and, as so often happens under conditions of monoculture, some pests and diseases have become serious. Although one in particular, Swollen Shoot, has attracted considerable attention and has, locally, become a political issue, appreciable losses have been and are being experienced as a result of capsid attack, although recently successful measures for the control of this pest on young trees have been introduced.

The cacao farm

Before we consider more fully the disease problems and possible methods of overcoming them, a general picture of what cacao farms look like and a few remarks about the organisation of cacao research in West Africa will provide a useful background against which later discussion can take place.

Fig. 1—Inside a West African cacao farm

Any word used to describe the areas where the cacao trees grow, be it 'farm,' 'plantation' or 'estate,' gives an impression of orderliness which simply does not exist. The beans are sown closely together in a haphazard way under forest shade trees and, when the cacao is established, food crops (yams, etc.) are grown in the intervening spaces. Forest paths or tracks lead the farm labourer or the traveller on his winding way among the trees. Oil palms and forest giants (silk cotton trees) which may tower 200 ft. above the canopy are also found throughout the cacao area.

Figs. 1 and 2 show typical cacao country through which the traveller can walk for miles without coming to a road or track large enough for a vehicle to be driven. Under such conditions, in which the trees are growing closely together with their branches intermingling, an ideal environment exists for the rapid spread of insects and of insect-borne disease.

The West African Cacao Research Institute

The disturbing reports of the spread of cacao pests and diseases in West Africa was one of the main reasons for the visit in 1943 of the editor of this journal, Dr. (now Sir) Harold Tempany, then Agricultural Advisor to the Colonial Office, to examine the positions in detail. He con-

firmed the views of some of those on the spot that a vigorous attack on the problems by entomologists and plant pathologists in particular, and by other specialists, was necessary if disaster was to be avoided. Although investigations were being actively pursued in both the Gold Coast and Nigeria the total effort was too diffuse and required to be concentrated into one organisation, strengthened and properly co-ordinated. Thus in April 1944 was the West African Cacao Research Institute born, with its headquarters, laboratories and experimental plots at Tafo in the Gold Coast, near the centre of the area already devastated by Swollen Shoot disease.

Under the Director there are a principal research officer and four divisions headed by senior specialists. The divisions are: (1) entomology, (2) pathology and botany, (3) soil science and chemistry and (4) agronomy. While these divisions undertake some investigations alone they obviously cannot work in isolation on other researches, for example on Swollen Shoot problems, when two or more divisions collaborate. An interesting account of the West African Cacao Research Institute has been given by the Director, Mr. O. J. Voelcker.[2]

The immediate task of the newly-formed institute was to tackle the two major menaces to West African cacao, capsid attack and Swollen Shoot disease. A certain amount of information was already available; for example Posnette had shown some time before (1939) that Swollen Shoot was a virus disease and Cotterell had obtained data on the two main capsid pests of cacao, *Sahlbergella singularis* and *Distantiella theobroma*.

The existing information was co-ordinated and both long- and short-term programmes of work were initiated.

Capsid pests

Capsid attacks can cause very serious damage to both mature and young cacao trees and, whereas the former generally survive, the latter generally do not. Here then was a problem as important as Swollen Shoot, for heavy losses of young newly-planted cacao were occurring every year. It was shown that in mature trees the damage following capsid attack was caused by the invasion of the affected tissue by the fungus *Calonectria rigidiuscula*. Young trees, however, would succumb to capsid attack without further infection by the fungus, thus causing a serious state of affairs in new plantations.

Recent work at W.A.C.R.I. has shown that capsids on young cacao can be controlled by the application of DDT emulsion to the trees. A very simple technique has been evolved which can easily be applied by the farmer. The technique consists of treating the stems and leaf axils of the seedling plants with 2½% DDT emulsion, using for this purpose simply a small paint brush and a small (50-size) cigarette tin to carry the insecticide. The success of this measure has been already indicated by the requests of the farmers who provided the control plots for their trees also to be given the medicine to save them as on the treated plots. This technique should soon be applied much more widely with a consequent marked saving of young trees. The method is perfectly satisfactory so long as the tree is no taller than about 7 ft., after which the very difficult question of application has to be faced, a question which is dealt with later in this article.

Swollen shoot

As its name implies, the symptoms of this disease are characteristic swellings particularly noticeable on new shoots, for example from the base of the tree.

The following facts have been established about the disease:

(*a*) It is caused by a virus of which a number of strains have been isolated, varying in the intensity with which they affect trees from death within a year to being apparently innocuous.

(*b*) The virus is harboured in certain forest trees, including the giant silk-cotton trees, which are apparently tolerant of the disease and very often do not show symptoms of it.

(*c*) The virus is transmitted by mealy bugs (*Pseudococcus spp.* including *Ps. syalensis*, *Ps. citri*, *Ps. bukobensis*) which live on cacao and on other forest trees particularly *Canthium glabriflorum*.

(*d*) The mealy bugs are attended by various species of ant which feed on the honeydew they secrete and protect them from predatory insects and even go to the extremes of building small tents of waste vegetable matter over them once they are established as a colony.

Thus it will be seen that, apart from the 50,000,000* infected cacao trees, there are in the forest 'reservoirs' both of the virus and the mealy bugs.

So far no means of controlling the spread of Swollen Shoot, other than by 'cutting out,' has been achieved. As will be appreciated, this measure was not popular when introduced as it often meant the removal of trees still bearing well. Nor is it popular yet, except in the worst-hit areas, in spite of the compensation which is paid for each tree removed and for rehabilitating an area after cutting out. In fact, there was so much opposition that an independent international scientific commission visited the area to determine if any other method of treatment could be adopted. Their report[3] emphasised the seriousness of the position and confirmed that cutting out was the only known possible method of controlling the spread of the disease. Further, they indicated that the policy would have to be carried out with speed and on a greatly increased scale if the disease was to be controlled at all.

Fig. 2—Typical view of cacao country from the road

*The number of infected trees is increasing at the rate of 5,000,000 per annum.

In addition to the roguing of infected cacao trees it is also essential to remove the four species of forest trees which are known to be alternative hosts for either the virus or the mealy bugs and ants. This is a difficult problem as the silk-cotton tree is a giant about 200 ft. high with large flat buttress roots extending up to 12 ft. from the trunk at the ground level and extending upwards for between 20 and 30 ft. If a giant tree of this kind is felled, a not inconsiderable task, it causes great damage to the surrounding cacao and in addition continues to throw up green shoots for many months. It has been observed, however, that trees which have been killed *in situ* disintegrate piecemeal and that little damage is done by the falling pieces.

It has also been observed that the silk-cotton tree has been killed by ring barking. The ring barking of smaller trees has been effected by means of a detonating fuse which, when fired after being lapped around the trunk, lifts the bark so that it is easily removed with a small axe or a cutlass. Fig. 3 shows the bark being removed from a tree so treated.

Experiments in which this technique has been used have been made on larger trees, but it yet remains to be seen if this method will lend itself to economic application.

The density of distribution of these trees varies considerably, but it is estimated that there is a total of about half a million of them in the Swollen Shoot devastated area which need to be destroyed.

Organisation of the cutting-out programme

It will be understood that the cutting out of cacao and the alternative host trees is a formidable task. For the relatively small cacao trees, the felling operation is simple, but the trees have to be examined for symptoms of disease and marked before the felling squad goes into action. This work is administered by the Department of Agriculture, whose area officers engage African staff for the work. Some of the staff are trained in methods of detecting the diseased trees while the remainder operate in gangs for felling and stacking the diseased trees. When it is agreed that an area is to be cleared (growers in the devastated area are far more co-operative than others) the first operation is the determination and marking of the farm boundaries, after which the ' spotters ' seek out the diseased trees and mark them by slashing the bark. Before the axemen arrive to fell the tree by cutting through the tap root about 9 in. below ground level, a gang of labourers clears away the soil from the bole of the tree and severs any surface lateral roots (Fig. 4). The photograph (Fig. 5) of a felled tree shows the extent of the clearance of the soil before the felling. After felling, the branches are removed and stacked with the trunks in neat piles.

Any mealy bugs trying to leave the felled tree along the forest carpet are almost certain to fall the victims of the many predatory insects which abound in these areas. Therefore, while the transfer of infected mealy bugs could be effected mechanically during the felling of a tree by contact of its branches with those of a non-infected tree it is most unlikely that any transfer takes place after felling.

Alternative methods of swollen shoot control

It has been stated that cutting out is the only method of controlling the spread of this disease, a view which was confirmed by the international commission. It is natural to ask the question, ' Will it ever be possible to control it by any other means?" To find the answer we must have a glance at three lines of advance which have been made in recent years:

Fig. 4—Close-up of tree prepared for removal. The lateral roots have been severed prior to cutting through the tap root about 9 in. below soil level

(1) in the field of insecticides, (2) in the field of plant chemotherapy for the treatment of fungal and virus infections and (3) methods of application.

Insecticides

DDT was introduced in 1942, but it was a few years before supplies became available for agricultural use. The efficacy of this insecticide for capsid control has been demonstrated. DDT does not, however, materially assist in the Swollen Shoot problem, but it has a slight deterrent effect

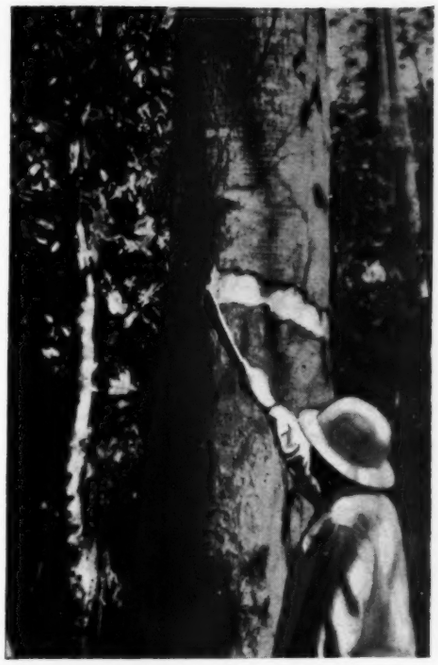


Fig. 3—Starting to remove the bark after ring-barking

on ants, which frequently transport the mealy bugs to new trees; on this account it tends to delay infestation of young trees by ants and mealy bugs.

Mealy bugs and other sap-sucking insects have been controlled by the well-established insecticide, nicotine. The organo-phosphorus insecticides developed by Schrader in Germany during the war as nicotine substitutes have also been found to be effective against some species of mealy bugs. Among the organo-phosphorus compounds, however, Schrader found a few with plant chemotherapeutical activity, a property since termed by H. Martin ' systemic ' insecticidal activity. These compounds are absorbed by the plant tissue and translocated in the sap stream to different parts of the plant, where they remain toxic to sucking insects for two to four weeks. Compounds absorbed in a similar way, but with effect against fungal and virus infections, have been described by Horsfall and his collaborators.

The author is of the opinion that a systemic insecticide, formulated in such a way that it can be observed by the leaves of the cacao tree, offers the most promising alternative to cutting out, although it may be possible, by using some of the more recently developed machinery, to achieve a measure of control by means of sprays containing such insecticides as nicotine, HETP, TEPP or Parathion, which exert either fumigant or contact and fumigant insecticidal activity.

At the Second International Congress on Crop Protection, Dr. J. G. Horsfall described the progress made in this field at his laboratories at New Haven, Connecticut, U.S.A. It has been found to be possible to reduce significantly the symptoms of virus and fungal infections by means of chemotherapeutical agents.

So far, the best absorption and distribution of the agent has been achieved when application has been made to the soil or nutrient liquor so that the absorption has been through the roots of the plant. Nevertheless some absorption has been effected when sprays have been applied to the leaves, but subsequent distribution in other tissues has in some circumstances been found to be poor, as it was also when the chemotherapeutant was injected into the vascular tissue of the stem.

The effective compounds have been found to function in different ways, as shown in the following examples. The virus responsible for X-disease of peaches has been inactivated by the treatment with quinhydrone of peach buds carrying the disease and the tobacco mosaic virus has been prevented from multiplying by malachite green but has not been inactivated by it.

Although no compound has yet been found to act in either of these ways on the Swollen Shoot virus, there is the possibility that one will be discovered if a concerted attack is made on this aspect of the problem.

Spraying technique

The recently developed equipment referred to above has been designed to apply evenly, lower volumes of more concentrated insecticides, etc., than have, hitherto, been customary. In orchards for example, the conventional type machinery uses up to 600 gal. of spray liquid (mostly water) per acre. Using the ' mist blower ' type of equipment, large volumes of air replace most of the water and carry the small particles of spray liquid, which have been injected from jets into the air stream, to the branches and foliage of the crop.

Where only a short ' carry ' of liquid is needed, the required distribution of particles is achieved without any air blast by using a number of suitably designed nozzles satisfactorily spaced on a spray boom. There are considerable differences of opinion as to the extent to which low-volume applications will supersede the conventional spray treatments, but it is certain that there will be a place for low-volume equipment within the range of agricultural spray operations. Provided that effective insecticides can be found, one of these will be for the treatment of cacao trees for the reasons given in the next section.

Application of new methods

The haphazard plant of cacao trees in irregular-shaped farms, fitting together like pieces of a jigsaw puzzle, has already been described and mention has already been made of the absence of roads or tracks capable of carrying vehicles or large spraying gear. For this reason, portable machinery, *e.g.* equipment fitted with skids and handles to enable it to be carried like a stretcher by two men, is the largest practicable type of machinery possible and even this would require a certain amount of skilful negotiation through parts of the farm. Smaller equipment still, of the stirrup-pump type, would be advantageous. It would also be practicable, as there is no shortage of labour for the work.

Further, there are no water supplies available and therefore it will be necessary to resort to the low-volume technique if anything approaching widespread application is to be achieved, at any rate until water is more readily available all over the area.

Objections that such equipment would need skilled maintenance are valid up to a point, but bicycles and motor-cars are run and have to be maintained in the area concerned and it would appear to be mainly a question of organisation to overcome difficulties arising on this account.

Thus we see that a spray treatment of any kind which may be developed will have to be such that it can be applied in this way. Now, although it has been found in Canada and the U.S.A. that sufficiently uniform application of orchard sprays for effective pest control can be achieved by low-volume applicators of the mist-blower type, there is all the difference in the world between a properly planned and spaced orchard and a cacao farm (Fig. 6).

It may, however, be possible for a sufficiently uniform application to be made of a contact insecticide for an effective control to be achieved of a pest which was exposed, but the mealy bug which we are after has in many instances protective tents built around it by its attendant ants. For this reason, a systemic insecticide which is not so dependent on initial uniformity of distribution (as this is effected in optimum cases by the sap stream itself) and which reaches the pest in its natural food, the sap, would appear to offer the best chance of success. A chemotherapeutic agent, effective against the virus responsible for Swollen Shoot and capable of being absorbed through the leaves of the tree, may also be largely independent of uniformity in the initial application, owing to its subsequent translocation in the sap stream, although the work on other virus diseases has shown that much better absorption has resulted through the roots of infected plants. Of these two possible alternatives to cutting out, the former is the more likely to be achieved first, as we already have compounds which are known to control insect pests similar to the vectors of Swollen Shoot disease.

Mammalian toxicity

There are, naturally, many points to be considered in the investigations along these lines, which are now being actively pursued. A very important one is the mammalian toxicity of the compounds known to possess systemic insecticidal activity. Whereas the direct effects of such compounds are easily guarded against in temperate climates by the use of protective clothing, it may not be so easy to do so in the tropics. Of the indirect effects, that of the contamination of the food crops of the Africans which grow under the cacao

Fig. 5—A cacao farm after cutting out, showing stacked felled trees. In the background is a silk cotton tree with buttressed roots

Fig. 6—An example of straight-line planting on the W.A.C.R.I. Estate

may be the most difficult to deal with. Obviously the cacao itself will have to be examined for possible accumulation of insecticide, but by the correct timing of the application in relation to the harvest, difficulties on this score should not be insuperable.

Another important point to be watched is the effect of the insecticides on beneficial, pollinating insects. The danger of overlooking such effects has been so forcibly demonstrated in recent years in control measures on other crops that it is not likely to be neglected in the studies in hand or contemplated on cacao.

This article would perhaps be incomplete if it did not contain a reference to the possible use in control measures of the latest form of aircraft, the helicopter, Over the vast majority, in fact probably all, of the cacao area, low-flying orthodox aircraft would be ruled out on account of the hazards in the form of forest trees of different heights projecting through the cacao canopy. Helicopters, however, with their greater manoeuvrability, might be used, particularly if a suitable systemic insecticide is found which does not require especially uniform application to the tree.

The next few years should bring most interesting developments in all pest control work. The developments as far as the cacao crop is concerned will not only be of great interest but of the utmost economic importance.

REFERENCES

1. H. Tempany: 'The Threatened Future of Cocoa,' WORLD CROPS, 1949, **1** (1).
2. O. J. Voelcker: *Nature*, 1948, **161** (4082).
3. 'Report of the Commission of Enquiry into the Swollen Shoot Disease of Cacao in the Gold Coast', Colonial No. 236, Stationery Office, 1948.

Place of Research in Increasing Labour Production

Dr. W. E. Keepper, of Pennsylvania State College, who served as consulting agricultural economist in the Department of Agricultural Economics and Rural Life from July 1948 to July 1949, has prepared the following summary of a seminar paper he recently presented at Turrialba, Costa Rica.

Research and education aimed at increasing the quantity produced per unit of labour used eventually will help raise the standard of living of all who contribute to agricultural production. This is true provided that economic, social and political conditions are such that the returns from production will be permitted to flow to each in proportion to what he has contributed to production.

Wage rates and accomplishment per unit of labour used in tropical agricultural regions are low in comparison with those in temperate areas. When judged by the standard of people from temperate agricultural regions, the level of living of tropical agricultural regions is also low.

Low agricultural wage rates and low productivity are interrelated. In turn both are determinants of the standard of living tropical agricultural workers are able to maintain. Other determinants are the current economic, social and political conditions which prevail in tropical agricultural regions. If governments are unstable, if educational facilities are limited, if alternatives for different types of employment are few, if the returns received by labour are not in proportion to what it contributes to production, then agricultural labourers will have little opportunity or incentive to further increase their output.

Despite the relatively low wage rates paid to tropical agricultural workers, the scanty information available indicates that labour constitutes the most important item among costs of production. In Puerto Rico, for example, research studies show that labour accounts for about 33% of total costs of 224 coffee farms, 1934; 44% of total costs on 270 tobacco farms, 1936; and 46% of total costs on 130 sugar cane farms, 1934.

Data gathered on four Costa Rican coffee farms in 1948 indicate that 40% of production costs, 63% of harvesting costs, or 48% of overall costs, was accounted for by labour. The importance of making more efficient use of this major cost item cannot be over-emphasised.

Basically, labour efficiency or high output per farm worker depends upon:

(1) Amount and distribution of work to be done during the year relative to the labour force available.

(2) Productivity of crops and animals on which labour is used.

(3) Adaptation of workers to jobs according to physical strength, mental capacity and mechanical ability.

(4) Workers' living and working conditions, including amount received for their work and how they receive it.

(5) Whether the work is done with regard to timeliness, routine and organisation.

(6) How the work is done, motions used, amount of travel, necessity of the task, location of equipment and materials, what is used to reduce human energy requirements (power, machinery, tools and other devices).

When the problem of increasing human labour efficiency is mentioned, the usual reaction is that mechanisation is the only possible answer. However, in the United States careful analysis of hand labour jobs, such as picking potatoes, tomatoes or snap beans, gathering eggs, feeding cows and similar tasks, has resulted in a 15 to 50% increase in efficiency, depending on the job. This was accomplished largely without replacing human labour by machines.

Personal observation of work methods used on routine tropical agricultural tasks indicates that increases in efficiency similar to the above can be realised. Such a realisation will depend in part upon the efforts of agricultural research and educational workers. Its realisation will also depend upon the efforts of those responsible for establishing clearly in the minds of workers the direct relationship between how much they accomplish and what they receive for their labour.

Italy Makes More Fertilisers

Italian production of nitrogen fertilisers during the year 1950-51 is estimated at 140,000 metric tons, a rise of more than 30% compared with the year 1948-49. The European Recovery Programme calls for an output in Italy of 160,000 tons in 1953.

Production of phosphatic fertilisers is also to be greatly increased in the year 1950-51, and for this purpose up to 1,000,000 tons of raw phosphates are to be imported, a considerably larger quantity than in the past. Some 650,000 tons will come from North Africa, 150,000 tons from the United States and smaller quantities from Egypt and other countries.

Antibiotics and Plant Protection

ERNA GROSSBARD, B.Sc.

Imperial College of Science and Technology

The use of antibiotics in medicine is now standard practice. Penicillin is a household word; it has revolutionised medical practice and saved thousands of lives. Streptomycin, aureomycin and chloromycetin are also rapidly extending their use in medicine. The employment of antibiotics in combating fungal and bacterial maladies of crops is in a much less advanced stage, but who can say whether in the future they may not play an equally important part in this field also? The nature and functions of antibiotics and their potentialities in regard to agriculture are discussed by our contributor, who is herself actively engaged in research on this fascinating subject.

ANTIBIOTICS are 'chemical substances produced by micro-organisms which inhibit the growth or interfere with the metabolism of other micro-organisms.' Penicillin and streptomycin are examples; they represent a new source of chemotherapeutics against diseases of man and animal and in the not-too-distant future, the plant as well. The term antibiotic is justified in the sense that these substances act 'against the life' (anti-bios) of micro-organisms, many of which are causal agents of disease; it is curious that they affect micro-organisms closely related to those which manufacture them. Thus patulin is produced by the mould *Penicillium patulum*, but inhibits the olive-coloured mould attacking citrus fruits, *Penicillium digitatum*, while streptomycin, produced by *Streptomyces griseus*, inhibits the growth of *Streptomyces scabies*, which is responsible for the scab disease of potatoes.

Micro-organisms producing antibiotics

Antibiotics are produced mainly by three groups of micro-organisms, most of which have been isolated from the soil, *viz.* the actinomycetes, the bacteria and the fungi.

Actinomycetes are very efficient seavengers, breaking down animal and plant residues in the soil. Many resemble bacteria, others are closely related to fungi, but their filaments are much thinner than the fungal threads. Certain actinomycetes are serious pathogens, causing actinomycosis in man and animals, or scab on potatoes. The number of antibiotics produced from actinomycetes is very great and increases daily. Streptomycin, chloromycetin, the new drug against typhus, and the two antifungal substances, *actinomycin* and *musarin*, are all produced by this group of micro-organisms.

This and the photo opposite by courtesy of Glaxo Laboratories, Ltd.

Sub-master culture of Streptomyces griseus

Many of the soil bacilli also produce antibiotics. Tyrothricin, consisting of gramicidin and tyrocidine, was isolated and crystallised several years before the discovery of penicillin, but its considerable toxicity limited its use in medicine. *Bacillus subtilis*, one of the most common soil organisms, produces at least four antibiotics, of which subtilin is probably the most promising. The antagonistic properties of the fluorescent bacteria of the Pseudomonas group were known in the nineteenth century and attempts were then made to use them therapeutically but with little success.

Fungi

Among the fungi the most efficient producers of antibiotics are the moulds, and of these *Penicillium notatum* is the best known. It is this fungus which has yielded the classic antibiotics, *i.e.* the penicillins. Other Penicillia and numerous Aspergilli also manufacture a varied range of antibiotics of less importance than penicillin, such as aspergillic acid, frequentin, gladiolic acid, gliotoxin, mycophenolic and patulin. They are among the few antibiotics which in laboratory experiments have so far been shown to inhibit the growth of plant parasites. The so-called higher fungi, *i.e.* the toadstools and mushrooms, have also recently been tested and a number of potential antibiotic producers found among them.

Production characteristics

The same antibiotic may be produced by several micro-organisms. For instance, gliotoxin is manufactured by the dark-green mould Trichoderma, by several

Penicillia, by *Aspergillus fumigatus* and by a species of Gliocladium. Patulin is another example; *Aspergillus clavatus* and several Penicillia, one of them a parasite on apples, all give rise to it and it is interesting to note that patulin, which is very active against plant parasitic fungi, is itself produced by a parasite.

On the other hand, the same species of micro-organism can manufacture more than one antibiotic. *Penicillium notatum* produces two antibiotics, penicillin and notatin, *Bacillus subtilis* yields several antibiotics and *Streptomyces griseus* manufactures streptomycin, grisein and actidione. Although these antibiotics are produced by the same species they differ greatly from each other and affect a different range of organisms. Penicillin acts mainly on bacteria of the group which is termed 'Gram-positive';* notatin on the other hand can inhibit both Gram-positive and Gram-negative bacteria in the presence of glucose. Two of the antibiotics formed by *Streptomyces griseus* are antibacterial only, while the third, actidione, is antifungal and does not affect bacteria at all. This specificity in their biological activity is a characteristic feature of antibiotics in general. Though penicillin succeeded where such powerful drugs as the sulphonamides failed, the number of bacteria affected by it is small, and fungi are not sensitive to it. There is therefore little hope that one day an antibiotic will be discovered which can act as a general remedy against all diseases, although one is perhaps justified in assuming that among the micro-flora of the soil one antagonist at least exists for any one micro-organism.

Properties of antibiotics

Antibiotics are by-products of the metabolism of micro-organisms, but they are not always formed. An organism can grow luxuriantly on a medium without giving rise to the antibiotic substance associated with it. In fact, it is only when the highly specific nutritional requirements are fulfilled and there is an adequate supply of oxygen and the correct temperature and other environmental conditions are satisfied that the desired antibiotic can be produced.

It has been suggested that the formation of an antibiotic is a sign of sickness in the micro-organism, but for this hypothesis there is little support.

*Gram-positive. A certain group of bacteria which when stained with certain aniline dyes and iodine have the power to retain the stain when treated with a decolorising agent such as alcohol.

Gram-negative. This group of bacteria becomes readily decolorised when treated with alcohol. It lacks the power to retain the primary stain.

Photomicrograph of streptomycin crystals at a magnification of 1,850 diameters

Chemical constitution

From the chemist's point of view antibiotics are a very interesting group, comprising many different chemical compounds, some of which are chemical novelties. Antibiotics can be polypeptides such as those produced by soil bacilli; some are quinones as fumigatin; others are lipoids, or pigments, or sulphur-containing compounds. Many of the antibiotics produced by moulds are organic acids.

Many antibiotics are water-soluble, which facilitates their isolation. Some are unstable, stability being dependent on such factors as acidity. Gliotoxin, for instance, retains its activity only when acidity is so great that no plant growth would be possible. Many substances inactivate antibiotics. Penicillin is destroyed by penicillinase, an enzyme of microbial origin; and *Bacillus subtilis*, which is most sensitive to the action of penicillin, is itself capable of producing penicillinase, thereby destroying its attacker.

How they work

The action of antibiotics is to inhibit growth rather than to kill sensitive micro-organisms. They interfere with cell division, enzymic action and other essential life processes. Antibiotics, however, are also lethal toxins and can kill and disintegrate living cells. Our knowledge concerning the exact mechanism of antibiotic action on sensitive micro-organisms is as yet still very scanty.

Antibiotics for plant protection

The causative agents of plant diseases are closely related to those responsible for illness in man and animal. The organisms responsible belong to the same three groups as those which produce antibiotics, *viz.* the actinomycetes, bacteria and fungi, and the great clinical success of penicillin, streptomycin and recently chloromycetin has stimulated the interest of plant pathologists in these new substances. Little work has been done, however, on the isolation of antibiotics for use as fungicides or bactericides, although the need for new materials of this description is great. Great progress has been made in the control of insect pests as a result of the discovery of DDT, benzene hexachloride and the organic phosphorus compounds, but to control fungoid diseases we continue to spray our fruit trees or potatoes mainly with the copper or sulphur fungicides of our fathers.

Some recent advances

In the last few years, however, attempts have been made to test the known antibiotics against plant parasites, while systematic investigations have been begun with the object of endeavouring to isolate new antibiotics, which, in particular, could be used to control fungoid diseases. Human diseases are caused mainly by bacteria, but the most important pathogens of plants are fungi, though it is true that some bacteria do attack plants and cause serious plant diseases. For this reason penicillin is of restricted value in agriculture, since it only affects a few plant pathogenic bacteria belonging to the Gram-positive group; examples are the bacterium causing crown-gall in apples, roses and other plants, and the tomato stem rot organism which, incidentally, is closely related to the diphtheria organism.

Most plant parasitic bacteria are Gram-negative and because streptomycin is very active against this group, many tests have been made with it and promising results obtained. Laboratory experiments have also shown that gliotoxin and viridine, isolated from *Trichoderma viride*, are very active against the causal agent of neck rot of onions and the fungus *Rhizoctonia*, which is responsible for the so-called 'damping off' diseases of many cultivated plants. The antagonistic properties of *Trichoderma* towards the fungus *Rhizoctonia* were known long before antibiotics were discovered.

Patulin inhibits the growth of bacteria, causing soft rots of root crops and also affects several of the fungi causing 'damping off' of young seedlings.

Mycophenolic acid is active against the tomato stem rot bacterium, wilt-producing fungi and the causal agent of silver leaf disease.

Musarin, recently isolated from an actinomycete from tropical soils, gave very promising results at low concentration against the agent of panama disease of bananas, against 'damping off' and against wilt fungi.

Gladiolic acid, produced by a *Penicillium* which is itself a parasite, attacking gladioli corms, is active against cereal pathogens, against the *Penicillium* which rots apples, against a spoilage organism of jam and, incidentally, poisons the fungus which produces it. This list is by no means complete, but it serves to illustrate the possibilities for the purpose of plant protection.

Difficulties to be overcome

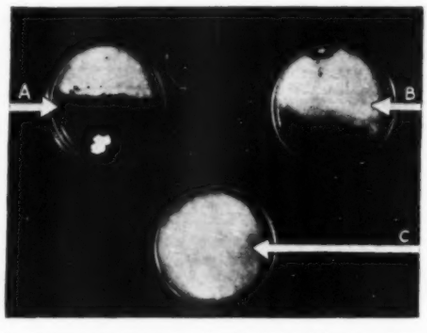
Not only is this type of research in its infancy but the difficulties which have to be overcome in utilising antibiotics as fungicides or bactericides are very great. Many antibiotics are toxic not only to such primitive plants as bacteria or fungi but also to crops. Many are unstable when exposed to the air or injected into the soil, where they may be destroyed by enzymes of microbial origin or by other agents. Some retain their activity only when acidity is very marked. Production costs are also all-important, but the success already achieved in synthesising chloromycetin induces the hope that ultimately it may be possible to produce antibiotics cheaply by synthesis.

Practical applications

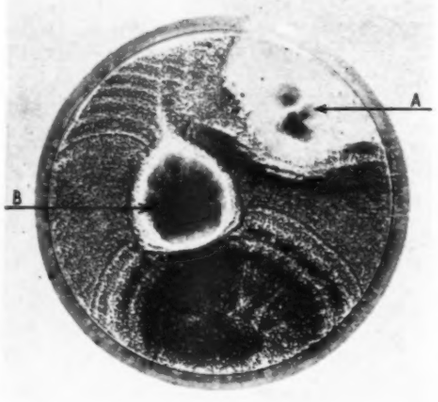
A few encouraging examples of practical application of antibiotics for disease control have already been reported. It has been claimed that gall formation can be arrested in plants attacked by crown gall when the galls are surrounded by cotton wool soaked in penicillin. Streptomycin is too toxic to the growing plant to be applied as a spray but seed is resistant and very good results have been obtained by dipping seeds from plants, infected with the tomato stem rot or angular leaf spot organism of the cucumber in a dilute solution of streptomycin. The treated seeds gave rise to healthy plants. Subtilin has shown promising results as a seed dressing against a disease of barley. Powdery mildews have been eradicated from plants treated with actidione at a dilution as low as one part per million. However, in spite of these promising results, the counterpart of penicillin for the plant pathologist has yet to be discovered.

Microbial antagonism

The farmer may have made use of antibiotic substances to control disease without being aware of it. This control involves the effects of microbial antagonism. This phenomenon has been known to occur in mixed cultures of micro-organisms for a very long time and its effects on disease control have been observed. It was not possible, however, to explain the mechanism of microbial antagonism which is defined as 'the phenomenon of a living micro-organism inhibiting the growth or interfering with the activities of another living micro-organism as a result of the creation of unfavourable conditions in the medium or the production of a specific antimicrobial substance.' The unfavourable conditions may consist in the exhaustion of food and oxygen supply, in the lowering of the acidity, in the limitation of the living space, in the accumulation of excess carbon dioxide and so forth. In short, microbial antagonism is the manifestation of the competition between micro-organisms in the fight for survival.



A streptomyces, isolated from the soil, inhibited development of an important root parasite. In dish (*a*) the white fluffy growth of the parasite is arrested; in dish (*b*) another mould is used which is not antagonistic to the parasite; in dish (*c*) the parasite alone has been inoculated



Action of two moulds (*a*) and (*b*) on the tomato root rot organism Colletotrichum atramentarium. Mould (*a*) was antagonistic to Colletotrichum which explains the area free of growth surrounding (*a*), while (*b*) was not antagonistic. Consequently the Colletotrichum colony grew closely around mould (*b*)

Many of the organisms which cause plant diseases live in the soil and it has long been known that the composition of the soil microflora can exert a controlling influence on them. This effect is closely connected with microbial antagonism; when a soil has been sterilised, competition between micro-organisms is reduced or eliminated, and when such a soil becomes later invaded by a parasite the disease spreads much more quickly and is more virulent than in a natural non-sterilised soil. Thus the microflora of the soil acts as a barrier to the invader.

Effect of organic matter

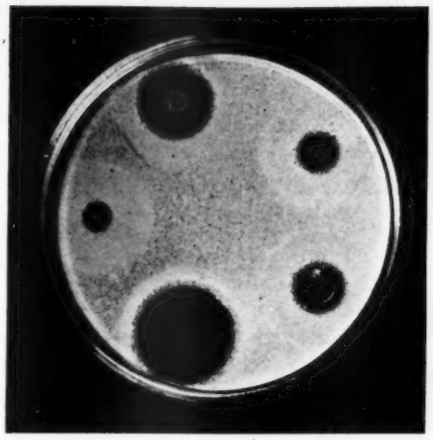
The incorporation in the soil of large quantities of organic matter may often bring about important changes in the microflora. Normally there is equilibrium among the micro organisms, but changes in the organic matter content may disturb this and profoundly affect the composition of the microbial population both in regard to numbers and type. Heavy applications of organic manure stimulate the growth of saprophytes, which live normally on dead organic material and do not attack the living plant. In some cases their development may be at the expense of plant parasitic organisms which are antagonised by them in some way not yet fully explained. Thus it has been found that land infected with potato scab gave good yields when dressed heavily with grass cuttings. Control of root disease of wheat, cotton and strawberries has been obtained by manuring with organic matter rich in carbohydrates and low in nitrogen.

Antibiotics in the soil

The definition of microbial antagonism mentions the production of antimicrobial substances. Are these materials antibiotics? Many saprophytes when brought in the laboratory produce under artificial conditions antibiotic substances, some of which inhibit the growth of plant parasites. Are we justified in assuming that a similar process takes place in the soil in the natural environment of these antibiotic-producing micro-organisms? What part, if any, do antibiotics play in microbial antagonism and subsequent suppression of soil-borne parasites? It is not yet possible to state definitely that antibiotics are present and active in the soil but there is a certain amount of indirect evidence that this may be the case. Experiments with certain soil

saprophytes have proved that when these fungi grow on materials such as straw, grass or bracken an antibiotic substance is formed which probably is identical with that produced on laboratory media.

Furthermore it has been possible to extract an antibiotic from sterilised soils inoculated with the blue mould *Penicillium patulum* (which gives rise to patulin), which inhibited the growth of many plant parasites in laboratory experiments. However, conditions in natural soil differ greatly from those in a sterilised soil and one is therefore reluctant to draw final conclusions. It is nevertheless significant that the treatment required for antibiotic production in a sterilised soil was very similar to that which brought about control of certain soil-borne diseases. Recent experiments have also shown that an antibiotic in low concentrations could be extracted from natural soil which had been treated with glucose, straw or other organic carbon compounds.



The glass dish was filled with a nutrient jelly sown with a soil bacterium. The dense white film represents bacterial growth and the centres of the dark circles are where sterile soil extracts were placed. Antibiotic substances were present in the soil extracts and prevented bacterial development

Future developments

These academic investigations into whether or not antibiotics are present and active in the soil may have important practical results, since they may eventually make it possible to induce artificially the production of antibiotics in the soil which are active against soil-borne plant parasites, thereby enabling the control of a disease at its very origin. Some experiments on these lines have already been carried out and have given both successful and unsuccessful results. They consist in the inoculation of soil with bacterial or fungal cultures known to antagonise a given plant pathogen. Russian scientists claim that the inoculation of seeds with antagonistic bacterial cultures, has led to the suppression of diseases of wheat. Recent reports from India claim a control of wilt on cotton by introducing bacterial cultures into soil harbouring the disease, but these latter experiments were made on a laboratory scale only.

The earliest work on these lines has been carried out on the 'damping off' disease of citrus seedlings; it was found that when the antagonist *Trichoderma* was introduced into an infected soil, a large proportion of the citrus seedlings planted in it remained healthy. It was demonstrated that the fungus *Trichoderma* disintegrated the fungal threads of the parasitic organism bringing about its death.

Trichoderma produces the two antifungal antibiotics gliotoxin and viridin.

In recent experiments in this country on 'damping off' disease, manuring of the soil in addition to inoculation with antagonistic organisms was carried out. The results were promising but not entirely consistent; in some cases the disease was stimulated.

Conclusions

Our knowledge concerning this type of biological control of disease is still very limited, and a great deal more research is needed before the possibilities can be fully assessed. All investigations into the biological processes of the soil are difficult, but the possibilities of this novel method of disease control makes the work well worth while pursuing.

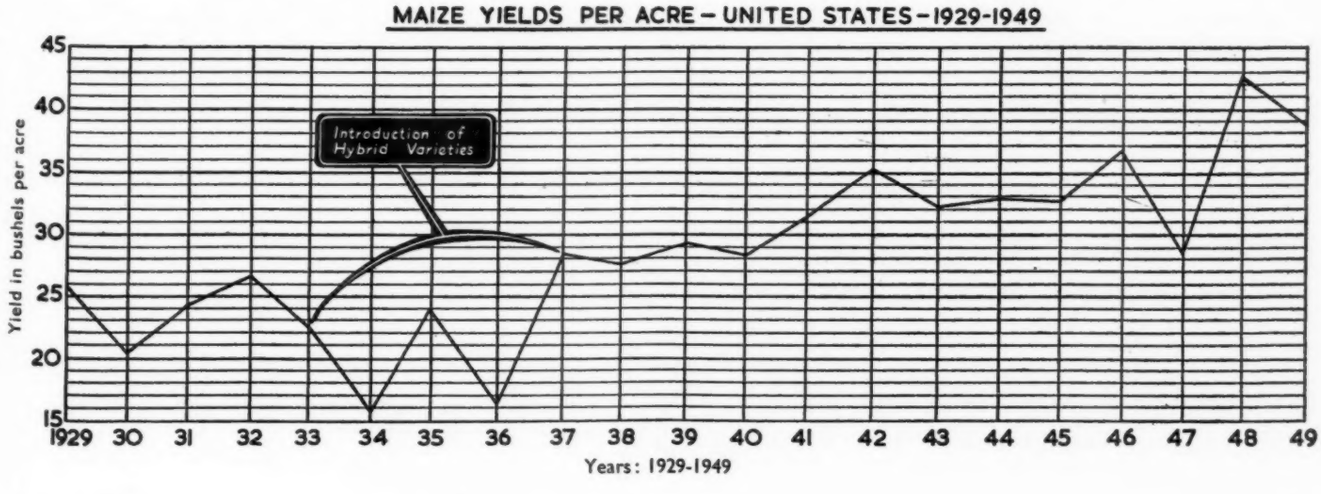
If ultimately a method of satisfactorily controlling soil-borne diseases by the use of antibiotic measures is found it might eventually be possible to eliminate some of the costly and elaborate methods which are at present employed.

Effects of Hybridising Maize in the U.S.A.

The average yields of maize harvested in the United States have markedly increased during the last 20 years, as a result of the introduction of hybrid seed which began to be widely used from about 1936 onwards. In an article by E. S. Bunting in this journal (Vol. II, No. 1, January 1950), it was stated that in 1933 hybrid maize occupied no more than 0.1% of the total maize acreage of the country; in 1946, 99% of the maize acreage of the most important maize growing state, Iowa, was planted with hybrid seed.

The effect of this introduction on maize yields in the U.S.A. is strikingly illustrated in the accompanying graph which shows the average return of maize per acre during the past 21 years over the whole of the maize growing regions in that country.

Many other countries are now introducing the use of hybrid seed.


MAIZE YIELDS PER ACRE – UNITED STATES – 1929-1949
Introduction of Hybrid Varieties
Yield in bushels per acre
45
40
35
30
25
20
15
1929 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
Years: 1929-1949

The Clove Industry of the Zanzibar Protectorate

Part II

R. O. WILLIAMS, O.B.E.

General Manager, Clove Growers' Association, Zanzibar

In this concluding section of his article, the first part of which appeared last month, the author deals particularly with the 'Sudden Death' disease of the clove tree which has wrought havoc in clove plantations and baffled investigators for nearly forty years. He also discusses questions connected with the marketing and disposal of the clove crop.

BY and large, not many diseases or pests affect clove trees. In fact serious, uncontrollable diseases are restricted to one only, if it is accepted that another major trouble, the 'die-back' of trees on marginal lands is, primarily, a result of planting in bad situations.

'Sudden Death' disease

This disease, known as 'sudden death,' has remained unidentified and uncontrolled for more than half a century despite investigations undertaken by many workers since 1912. The results of the latest research suggest that the trouble may be caused by a virus, transmitted by scale insects, transported to the trees by ants.

Sudden death appears to be endemic in both Zanzibar and Pemba; a similar malady, known as apoplexy, has been reported from Madagascar since 1904. The appearance of stricken trees is not dissimilar to that of those dying from drought, but they are easily distinguishable at the time death occurs. Sudden death progresses by contact, and the leaves remain shrivelled on the trees for some time after death. Trees suffering from drought, on the other hand, die *en masse* and the leaves are shed. Later, when the shrivelled leaves have fallen, no distinction can be made either from the air or on the ground and the cause can only then be guessed from the topographical conditions and the history of the case. Furthermore drought affects all trees of every age and description, while sudden death is almost entirely restricted to clove trees, and the older ones at that.

The position in Zanzibar

The losses of trees in Zanzibar from the malady have been very heavy, and the practice of leaving dead trees standing as a protection for young seedlings shows the disease in its worst and most cumulative aspect; the land under these trees has, however, been largely regenerated. In 1947 Dr. Nutman, Acting Director of the Clove Research Scheme with the Director of Agriculture estimated from the air that at least half of the total number of trees in Zanzibar island had died within the past 12 years or so. This would mean a loss of 500,000 trees at the generally accepted estimate of the clove tree population. During this same 12 years, 1,096,000 seedlings were distributed in Zanzibar. The policy of Government since 1922 has been to raise and distribute in both islands large numbers of clove seedlings for regeneration purposes and this provided replacements far outnumbering the deaths from all causes even when planting in pairs, a common custom, is allowed for.

Some idea of the age composition of the present clove population in Zanzibar may be gained from a record, made in 1940, of a

A roadside view of a devastated area

Example of trees stricken with Sudden Death showing shrivelled leaves

An example of Sudden Death in a closely-planted plantation

number of plantations under examination for indebtedness. It was found in that year that 18% of the trees were 12 years old, or younger, and annual plantings on a large scale have continued ever since. The wisdom of this Government policy may be judged not only by the high level of production which has been maintained, but also by the large number of young trees of ages ranging from 1 to 27 years.

The position in Pemba

The progress of sudden death in Pemba is rather different from that of Zanzibar. My own observations agree with those of Tidbury*, who records single deaths as common and adds that frequently the loss of trees ceases when a group of a dozen or so have succumbed, the gap so formed being planted with seedlings. The Arab owners in the island have apparently accepted this position with equanimity in the past even with much larger losses, such as 200,000 trees, in the year 1897. The Director of Clove Research estimates that there are some 500 of these small outbreaks in Pemba and it is the present intention, based on scientific advice, to isolate them by cutting out the dead, dying and contact trees numbering 60,000 to 100,000. More than 600,000 seedlings were planted during the period 1937 to 1948 in that island, and the large number of young trees of 1 to 27 years of age is, as in Zanzibar, a bright feature of the position.

So long as this annual rate of replanting is continued in both islands and, provided the young trees are given the necessary care and attention, the Zanzibar Protectorate should remain the principal producer of cloves, but if for any reason it is discontinued, then ultimate reduction in the average annual output must, obviously, be expected.

Replanting

From an agricultural point of view the ideal time for replanting clove plantations is as soon as possible after the trees have died, while the land is still rich with organic matter originating from many years of semi-forest conditions and the standing dead trees serve as protection for the land and the seedlings; this system has been advocated by the agricultural authorities for many years. Where clear felling is practised the soil is exposed and deteriorating changes almost certainly set in, which may be followed by the invasion of grasses and noxious weeds or by a change over to annual crops with the attendant risk of mismanagement. If the planting of the clove seedlings is delayed, therefore, their progress will be slower, due to the deterioration in the land which has taken place meanwhile. Unfortunately, the latest theory of the cause of sudden death gives rise to recommendations for clear felling and postponing the replanting of clove seedlings for two years; these have been made with a view to preventing the carry over of the disease but are detrimental to the good of the land.

It is fortunate that sudden death occurs in the older groups of trees, and it is not common to find young trees or even middle-aged trees dying of it even in the replanted areas. It is true that some plantations which appeared to be good for many years to come have been destroyed by sudden death; in many other cases, however, where the branches have become crowded together and the cloves largely inaccessible, one cannot but feel that it was

**The Clove Tree* by G. E. Tidbury. Crosby Lockwood, London, 1949.

high time to replace the old trees in any case. If the idea for wider spacing of the trees and interplanting with cacao takes on it may assist in the control of sudden death when the trees reach the susceptible age.

Longevity of the clove tree

The characteristic restriction of this disease in its epidemic form to the older groups of trees gives food for thought as to the longevity of the clove tree. The first plantings in Zanzibar were mostly wiped out by the hurricane of 1872, when the oldest trees would then have been some 50 years old. There are comparatively few pre-hurricane trees to be found now and, except for these, the oldest trees cannot be more than 77 years old. The heavy losses which have taken place in recent years have, therefore, been mainly in the plantings since 1872.

It appears logical, therefore, to assume that the clove tree may be expected to be near the close of its career between the ages of 50 and 60 years, and particularly so as a manageable crop plant under the close conditions often existing.

Inspection and marketing

All cloves, when presented for local sale at the public clove markets in Zanzibar and Pemba, are subject to inspection under the Adulteration of Produce Decree; the moisture content must not exceed 16% and extraneous matter 5%; this includes stems and mother of cloves. Before packing for export all cloves must be taken to the export produce inspection shed under the control of the Department of Agriculture and emptied out of their bags; the bulk is then inspected and certified within the limits of grade standards which differ mainly as to the quantity of khoker, *i.e.* badly prepared cloves. The packages are bales wrapped with palm-leaf matting and tied with coir rope; the weights vary according to market requirements, 140, 175 and 185 lb. being usual. The bags for all phases of the internal use of the clove trade are supplied by the Clove Growers' Association; they are branded with the Association's trade mark and it is illegal to use them for any other purpose. When cloves are bulked for export the bags are returned to the Association for re-issue. The cost of the bags and their distribution is provided by a cess of 1s. per 100 lb. of cloves exported.

The actual buying and selling of cloves takes place in a picturesque setting under the shade of roadside trees near the offices of the Clove Growers' Association in Zanzibar, where local market prices are posted daily.

Clove Growers' Association

The Association is a public utility concern whose primary business is to establish a floor to the price of cloves. For this purpose guaranteed minimum prices are offered for the various grades of cloves over seasonal or shorter periods. The Association disposes of its stocks, in due course, by contributing a given percentage at fixed prices to consignments exported by private traders; it does not export cloves on its own account. The system works very well and traders are happy to obtain part of their export requirements from the Association and the growers to know that there is a floor to the market. It is a generally accepted axiom that the exporter, knowing that he can obtain a given percentage of any consignment at a fixed price from the Association, bids in competition with others to the benefit of producers for the remainder, which he must obtain in the open market.

Cloves may also be deposited by producers with the Association against a cash advance, and advantage is taken of this scheme for the purpose of holding for better prices. The Association also helps producers in various other ways. It grants short-term loans on chattel mortgage of the pledged crops for such purposes as weeding the plantations or picking and leasing the crops, and long-term loans for the purchase or maintenance of agricultural property secured by mortgage on immovable property. It meets one-third of the cost of the scheme of research into the sudden death problem and provides funds for the raising of clove, cacao and chillie seedlings for free distribution.

Taxation

The clove industry of Zanzibar has for many years been a main source of revenue to the Government, the basis of collection being an export duty of 20% of the overseas price of cloves less the cost of freight, transport and insurance and 10% of the local price paid for stems. Producers, however, are relieved of the liability for the payment of income tax.

Summary

To summarise: The Zanzibar Protectorate is the main producer of cloves and the world's supply fully meets requirements. The replanting policy of the Government of these islands has enabled production to be maintained, and even increased, over a long period despite heavy losses of trees by disease, drought and other causes.

Young clove trees growing in a plantation in which the older trees have succumbed to Sudden Death

Lower Sind Barrage

The Lower Sind Barrage, the foundation stone of which has been laid by the Pakistan Governor-General, is to be 1,000 yards long, will irrigate 2.75 million acres of land and generate 107,000,000 Kw. electric power. It will cost Rs.21 crores (in the neighbourhood of £23,000,000).

The barrage itself is to be ready by 1953. 'Before the current decade is out,' a reports says '2.75 million acres of desert land in Sind will be smiling with rich vegetation.'

Fertilisers and Grassland Production

The output from grassland can be enormous, and as a potential source of food production it is unequalled. In the United Kingdom grassland supplies half the basic food nutrients at a cost lower than any other source. Yet the potentialities have not nearly been fully realised and the present average yield from British grassland is low compared with that of farms where modern techniques of grassland husbandry are used. Fertilisers can play an important part in achieving increased production. The question is discussed in the following abstract of a paper recently presented to The Fertiliser Society in London by R. A. HAMILTON, B.SC., B.AGRIC., DIP.AGRIC. (CANTAB.), A.I.C.T.A.

IN 1947 a scheme was started to investigate the value of intensifying grassland husbandry on the output and general economy of farms in different parts of the United Kingdom. There are today over 70 commercial farmers in the scheme, which is practically in full operation. It is, of course, a long-term investigation, and conclusive results cannot be expected for a few years, but data are now available from some of the farms which have been in the scheme since 1947.

The measure of grassland output employed has been cwt. of starch equivalent* per acre. The average for the country is 10 to 12 cwt. per acre; this is too low and, by applying present-day techniques, it would be relatively easy to increase the output of grassland to 14 or 15 cwt. per acre. On a national basis this would mean approximately an additional 3½ million tons of starch equivalent, with a proportionate amount of protein, worth, at present-day prices of feeding stuffs, more than £100 million.

*The starch equivalent of a feeding stuff is the number of lb. of starch required to provide the same amount of energy as 100 lb. of the feeding stuff.

Photo : Top of this page

Controlled strip grazing. This field provided 277 cow-grazing days per acre during the season plus 2 tons of hay containing 9.1% crude protein

Comparative costs

Based on costing figures obtained from 56 farmers in 1948, grass is shown to be far the cheapest food for ruminants either in fresh or conserved state. The figures are shown in Table 1.

These figures are self-explanatory; not only does grass provide the basic food nutrients at a lower cost than any other source but it also supplies half the country's requirements.

The role of fertilisers

The most important factors determining grassland output are: (*a*) management,

TABLE 1

*COST PER TON OF STARCH EQUIVALENT AND PROTEIN EQUIVALENT PROVIDED BY GRAZING, HAY, SILAGE AND CERTAIN ARABLE CROPS IN 1948 COMPARED WITH THAT PROVIDED BY DAIRY CAKE.

Source	*Cost per ton starch equivalent*
	£ s. d.
Grazing (utilised)	6 10 0
'Early Bite' grazing (utilised)	10 0 0
Hay	15 0 0 (with 2.7 cwt. P.E.)
Grass silage	16 0 0 ,, 3.3 ,, ,,
Wheat (20 cwt. crop)	20 0 0
Oats (20 cwt. crop)	20 0 0
Potatoes (7½ ton crop)	38 0 0
Mangolds (24 ton crop)	30 0 0
Turnips (17 ton crop)	40 0 0
Dairy cake†	42 0 0 (with 6.3 cwt. P.E.)
Dairy cake‡	52 0 0 ,, 6.3 ,, ,,
Source	*Cost per ton protein equivalent*
	£ s. d.
Hay	110 0 0 (with 7.5 tons S.E.)
Grass silage	98 0 0 ,, 6.0 ,, ,,
Dairy cake†	133 0 0 ,, 3.2 ,, ,,
Dairy cake‡	167 0 0 ,, 3.2 ,, ,,

*The figures for mangolds and turnips were derived from published data.
†Based on present price of about £24 per ton.
‡Based on estimated unsubsidised price of £30 per ton.

(*b*) plant nutrient supply, (*c*) water supply and other climatic factors, (*d*) type of sward and (*e*) absence of harmful factors. The supply of plant nutrients determines the level of fertility and is the key to high grass production. The importance of a high level of fertility can be seen in Table 2, which shows how heavy a feeder is grass.

There is a great difference in the amount of plant food lost to the soil under varying conditions of management; for instance grazing adult cattle do not retain so much as young stock and, naturally, neither cause so great a loss as when the grass is cut and carried away.

Response to fertilisers

The difficulty of measuring response of grassland to fertilisers is far more complicated than when dealing with arable crops, which is a comparatively straightforward business. Such factors as the time of year when increased yields are obtained, the feeding value of the extra grass and the effect of treatment on future yields, all have a bearing on the results; accordingly it is not generally possible to use the ordinary harvesting techniques in measuring the response of grass to fertiliser treatment. From all the experimental work so far carried out, however, there is no doubt that grass generally responds well.

Lime is the basic requirement and the soil *p*H should not be less than 5.5 with an optimum of 6.0 to 6.5.

Phosphate is particularly important in maintaining quality in clovers, while increases in yield of 10 to 25% usually follow dressings with phosphatic manures.

Potash gives a marked response only on potash-deficient soils, *i.e.* after continued cutting and carrying away of the crop. Replacements can be made by applying farmyard manure or complete fertilisers.

Nitrogen largely determines growth and, by judicious use of nitrogenous fertilisers, output can be increased by 20 to 50%, particularly when it is used to stimulate early growth and provide the 'early bite.' In Great Britain the growing season is usually not long enough to enable clovers and other legumes to build up supplies of nitrogen through the action of symbiotic bacteria to meet the full requirements of the crop and so, even if the grass mixture includes clovers, the nitrogen supply—and hence the protein—must be maintained with the help of nitrogenous fertilisers. This has been realised in Holland, where the standard of grassland management is particularly high and 2 cwt. nitro-chalk per acre is the average dressing given to them.

In Table 3 are shown the results from one of the farms under investigation and, bearing in mind that the season was one of almost unprecedented drought, the high level of output of the legumes which received dressings of nitrogen is remarkable.

Present fertiliser practices

Fertiliser usage on both temporary and permanent grassland is at a very low level and from a survey of 22 counties between 1941 and 1946 it appears that 1 to 1½ cwt. of nitrogenous fertiliser was applied annually to only 1 acre in 8 to 12 of permanent grass and 1 acre in 4 to 6 of legumes. Similarly with phosphate, the usual applications are far below requirement. Scott-Watson has suggested that every acre of permanent grass should receive, as a minimum, the equivalent of 1 cwt. superphosphate per acre per annum, while the

TABLE 2

ESTIMATED QUANTITIES OF MAJOR PLANT NUTRIENTS EXPRESSED IN TERMS OF 'NITRO CHALK' (15.5% N), SUPERPHOSPHATE (18% P_2O_5), MURIATE OF POTASH (50% K_2O) AND LIME ($CaCO_3$) CONTAINED IN GRASS AND OTHER CROPS OF AVERAGE COMPOSITION AT VARYING YIELD LEVELS.

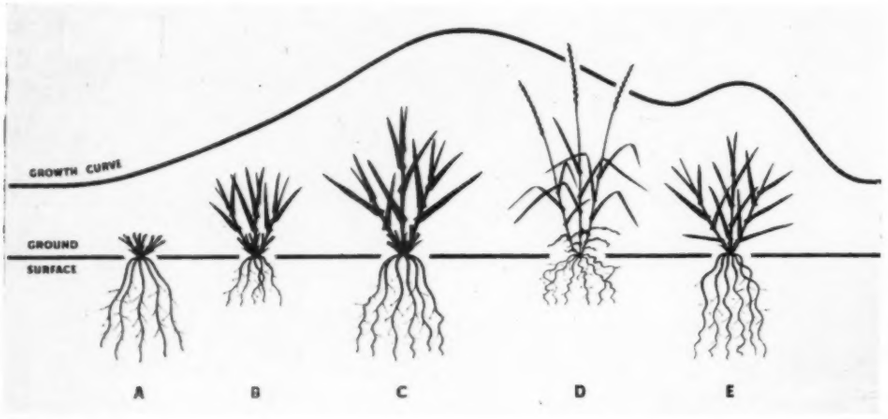
Crop	*Yield per acre*	*Cwt.*			
		'Nitro chalk'	*Super-phosphate*	*Muriate of potash*	*Lime*
Grass	30 cwt. dry matter	5.4	1.5	2.1	1.1
Grass	60 ,, ,, ,,	10.8	3.0	4.2	2.2
Grass	90 ,, ,, ,,	16.1	4.5	6.3	3.3
Wheat	16 ,,	2.6	1.0	0.5	0.1
Wheat	26 ,,	3.8	1.4	0.6	0.2
Oats	16 ,,	2.3	0.9	0.8	0.3
Oats	26 ,,	3.3	1.4	0.9	0.3
Potatoes	6 tons	2.6	1.2	1.5	0.1
Potatoes	12 ,,	5.1	2.4	2.9	0.2
Mangolds	20 ,,	4.1	2.0	3.6	0.2
Mangolds	40 ,,	8.2	4.0	7.2	0.4

TABLE 3. HENLEY MANOR FARM

PRODUCTIVITY OF LEYS ON SELECTED FIELDS IN 1949

Section	*Field*	*Type of ley*	*Cwt. per acre*		
			Dry matter	*Starch* equivalent produced*	*Crude protein*
'A' 11 cwt. 'Nitro-chalk' per acre	Limekiln (13 acres)	Cocksfoot, White Clover (S.100)	63.6	37.8	10.5
'B' (No nitrogen)	Henley Plain (14.5 acres)	Cocksfoot, White Clover (S.100)	41.9	25.2	7.4
'A' 8.5 cwt. 'Nitro-chalk' per acre	Part Forty Acres (10 acres)	Timothy, Meadow Fescue, Cocksfoot, White Clover (S.100)	97.6	53.4	15.3
'B' (No nitrogen)	Wensleys) (18 acres)	Timothy, Meadow Fescue, Cocksfoot, White Clover (S.100)	61.1	39.0	12.8

*These figures cannot be compared directly with other figures quoted for utilised S.E.



This diagram shows how a grass plant grows throughout the season

equivalent of 1½ cwt. nitro-chalk should be given annually to at least one third of the total area. Of course, there are many who use more than five times this amount, but the average for the country is far below this standard. The attainment of the 1952-53 food production targets depends on explanding grassland output by one third and this can only be done if good management is practised.

Grassland management

Grassland management means the correct use of grass, but it is important to realise that it entails an entirely different approach to that for arable crops.

The stages in growth of a grass plant throughout the season are shown in the illustration. In the spring the condition of the plant is represented by (*a*). It has good reserves and tiny shoots begin to appear which, under favourable conditions, develop to (*b*); adequate supplies of nitrogen help the plant to attain this condition early in the season. Later it will develop root and more leaves, becoming very vigorous. It then proceeds to fulfil its main object in life and produce flower and seed as at (*d*) and when this occurs the leaves become coarse and die back, the plant is reduced in vigour and becomes semi-dormant. Later in the season more leaves are formed, but not in such quantity as at (*c*) and reserves are built up again before winter as at (*e*).

Good management requires the removal of the leaf by grazing or cutting at the correct time, *i.e.* when there is a large quantity of good-quality leaf and the plant is in a vigorous state, so that it can quickly produce more leaf. These two conditions are fulfilled at (*c*) and (*e*).

Bad management results from removing the leaf when the vigour of the plant is low or the feeding value poor or both, and particularly by removing the leaf too near the end of the season. At stage (*b*), although quality is good, the plant is slow to recover if the leaf is removed; at stage (*d*) both quality and vigour are low; if the leaves are removed too late in the season at stage (*e*) the reserves available for growth next spring are unduly reduced.

However well a sward is managed there is unfortunately always a tendency to have peak and slump periods, particularly in a season of summer drought. To ensure against this a good manager should plan his operations in one or more of the following ways: (1) Sow a ley composed of grass and legume species which will withstand drought and continue growing during the midsummer period. Suitable plants for this purpose are the better strains of Cocksfoot, White Clover and Lucerne. (2) Re-seed a field in the spring; this will provide grazing during the midsummer period. (3) Set aside one or more fields to be cut for silage at stage (*c*). This will not only provide a store of good-quality food but also, as the plant is cut in a vigorous state, recovery will be quick and a cover provided before the drought sets in.

Beef production on grass. These cattle were fed on grass silage only from December to the beginning of April and the photo was taken at the beginning of May

Contributory factors to good grassland management, of which the efficient manager will make as full a use as he can, are the electric fence (giving 20 to 30% better grass utilisation), the green-crop loader, the buckrake and pit silage. A further factor which, in association with proper fertiliser technique, may play an important part in future grassland management is the use of selective weed-killers.

Some results of the scheme

Results of the grassland investigation scheme for a small dairy farm in an area of poor land in the North of England are shown in Table 4.

Prior to 1947, when this farm came into the scheme, the farmer had experienced difficulty in providing keep for his dairy cows, because of the shortage of feeding stuffs, not only in winter but also in summer. Since 1947 the figures show improvement in every respect and the profit per acre was 25% higher in 1948 than in 1947; had it not been for the drought still more progress would have been made in 1949. Fertiliser usage has increased tremendously; as a result of good management the pastures are now in good condition and the leys show no signs of the rapid deterioration formerly experienced. This year it is planned to increase the stock to 60 cow equivalents. To stock 60 cows on 72 acres of relatively poor land above 1,000 ft. is an achievement which could be replicated all over the United Kingdom by proper attention to grass production and utilisation.

Beef production

At one of the farms in the scheme 16 bullocks were purchased in October 1948 with an average live-weight of 10 cwt. They ran on grass until the beginning of December and were then fed on grass silage only until the beginning of April 1949, when their average live-weight was 11½ cwt. and they were in first-class con-

TABLE 4. PRELIMINARY DATA FOR HIGH-LYING NORTH OF ENGLAND FARM

	1947	1948	1949
Farm acreage	72	72	72
Acreage of grassland	65	65	71
Cow equivalents carried	44	47	52
Acreage of grassland per cow equivalent	1.5	1.4	1.4
Milk produced per acre of total land (gallons)	268	402	454
Quantity of silage made (tons)	—	—	72
Quantity of utilised starch equivalent provided by grassland (cwt. per acre)		17	
Fertiliser nutrients applied to all grassland in terms of:			
'Nitro-chalk' (cwt. per acre)	0.2	2.0	4.1
Superphosphate (cwt. per acre)	2.0	3.8	4.0
Muriate of potash (cwt. per acre)	0.0	1.2	0.7

dition. The cattle were then run on early grass and were ready for grading at the beginning of July; two were graded 'specials' and the remainder 'super-specials.'

Health of stock

Under most conditions grass is the best food for cattle and sheep, but under intensive stocking certain deficiencies in soil or herbage may occur; the grass manager must always be on the look-out for any trouble in this direction.

One of the commonest problems with leys, often associated with too much clover in the grass mixture, is the tendency to cause bloat in cattle; there must be a proper balance between grasses and clovers in the ley mixtures. In Holland occurrence of bloat is rare. The building up of internal parasites in sheep is another problem which has caused difficulty. This has largely been overcome by advances in veterinary treatment; for example a routine dosing with phenothiazine has solved the problems of worms in cattle and sheep.

Conclusions

The great importance of grass to the agricultural industry and the nation has been shown and, to obtain the required level of output, the necessity for a substantial use of fertilisers has been stressed. But it is useless to tackle the fertiliser aspect independently of other factors. The improvement of grassland can only be brought about by the closest attention to all the factors and by the fullest use of all available facilities. By carrying out some or all of the following practices, most dairy farms and rearing and fattening farms could increase their grassland output: (1) production of some early grass and extension of the grazing season in autumn; (2) making grass silage, especially in May or June; (3) better manuring and earlier cutting of hay; (4) providing against a mid-summer drought; (5) controlled grazing for better quality and utilisation.

It follows that improvements in grassland management can provide vast additional supplies of cheap fodder for stock and in this way contribute more than any other factor to lower costs of production for beef, mutton, milk, cream and cheese.

Pest Infestation Research Covers Wide Field

DETAILS of progress made by the Pest Infestation Laboratory in 1948 have now been published.

The Laboratory is primarily concerned with the insects and mites which destroy stored foodstuffs. It also deals with the factors affecting the safe storage of grain, etc.

The research programme includes work on clothes moths and on the infestation of slaughterhouses by blowflies.

Fumigants

Large scale experiments with methyl bromide have shown that completely effective fumigation of silo bins full of grain can be achieved only by circulating the fumigant through the grain. The addition of fumigants to the surface of grain in silo bins has failed so far to give satisfactory distribution of the gas throughout the bulk of grain.

To determine minute traces of fumigants and other insecticides present in treated foodstuffs and in insects, work has been started on the use of radio-active materials. A special laboratory has been equipped and work has begun with 'labelled' methyl bromide. This new technique should prove of great value not only in detailed examination of insecticidal residues, but also for a study of the penetration and site of action of insecticides in the bodies of insects.

Synthetic insecticides

The possibility of using synthetic insecticides for the control of stored-food pests depends very largely on the amount of insecticide that may be taken up by exposed foodstuffs. To this end, work has continued on the measurement of DDT residues in foodstuffs stored in sacks impregnated with insecticide. The amount absorbed was in some cases surprisingly high, and can be shown to be largely dependent on the fat content and the fineness of division of the foodstuff.

Work on DDT smokes has included measurements of the toxicity to insects of the actual smoke and of the films of DDT formed by the deposition of the smoke on building surfaces. It was found that not only were the deposits about 20 times as heavy on the floor as on the walls and ceiling, but surprisingly, the deposits at floor level contained 66%, by weight, of DDT. Those on the walls and ceiling contained only 12%.

Insect-proof packages

A patent has been taken out for a type of packing which has so far, under laboratory conditions, shown itself to be proof against insect penetration.

The method consists of the insertion between the walls of the container and its contents of a layer of cellulose wadding or similar material impregnated with DDT. This kind of material is attractive to insects, which like to congregate and wander along the folds. They are thus kept in contact with the insecticides for a time sufficient for them to pick up a lethal dose.

Fungi in grain

Work on this problem has involved the examination of large numbers of wheat samples received from different parts of the world. Almost all samples showed the presence of the fungus, those few in which it was absent having been apparently grown under irrigation conditions. Experiments in which growing ears of grain were enclosed in desiccator chambers, intended to simulate irrigation conditions in an arid climate, have resulted in the production of fungus-free grain. It is hoped that a repetition of this experiment on a larger scale will make it possible to determine the part played in grain respiration by the fungus normally present below the epidermis.

Ptinid beetles

A comparative study is being made of the biology of certain species of ptinid beetles. This investigation indicates whether or not certain species, at present not important as pests in this country, are ever likely to become so, and suggests reasons for such conclusions. Certain species, although able to develop rapidly under the climatic conditions normal in this country, are capable of laying only a very small number of eggs and are thus unlikely to produce major infestations. Other species are very slow in developing and others again require comparatively high temperatures for normal growth.

Insect populations

It is important that a satisfactory means should be found for linking up laboratory life-history data on individual insects with 'population dynamics.' In studying the rise and fall of insect populations many additional factors have to be taken into account, and the whole problem becomes greatly involved. To assist this approach to population problems a careful study has been made of the theories and evidence concerning the natural control of insect populations.

Pest Infestation 1948 is published by the Stationery Office, price 1s. (30 cents U.S.A.), by post 1s. 2d.

The Olive Industry in France and North Africa

P. BONNET

Directeur des Services oléicoles, Ministère de l'Agriculture

World shortages of oils and fats have naturally intensified interest in all forms of oil-producing crops. Olive oil was among the first oil crops to be utilised by man, and it still retains pride of place as the blandest and most nutritionally acceptable of the vast range of vegetable oils. Accordingly, the following account of the olive oil industry of France and her North African territories is of particular interest. It has been translated from a paper which appeared in the Bulletin Technique d'Information of the French Ministry of Agriculture.

THE olive is one of the earliest plants to have been utilised by man for the production of oil and it was for a long time the main source of supply; of recent years, however, it has been surpassed by other oil crops and today it is only fifth in importance with an average world production of 840,000 tons, representing 9% of the vegetable oil production of the world.

Geographical distribution

The growth of the olive tree is influenced much more by climatic than by soil conditions. It flourishes only under Mediterranean types of climate and under these conditions it shows a remarkable tolerance towards soils. In consequence its main areas of production are the Mediterranean and it is not surprising that the Southern French provinces and the territories of the French Union in North Africa are particularly important olive growing areas.

In Southern France the crop is grown in eleven Departments: Alpes-Maritime, Var, Basses-Alpes, Bouches-du-Rhône, Drôme, Ardèche, Gard, Hérault, Aude, Pyrénées-Orientales and Corsica; the estimated number of trees being 12,500,000, occupying more than 80,000 hectares.

In North Africa it is most extensively grown in Tunis where there are 25,000,000 trees distributed, in order of importance, among the regions of Sousse, Sfax, Tunis, Territoires du Sud (Southern Territories), Bizerta and Le Kef. In Algeria there are 12,000,000 cultivated trees of which 56% are in the Department of Constantine, 30% in the Department of Algiers and 4% in the Department of Oran; in Morocco there are more than 10,000,000 trees of which the majority are in the Fez and Marrakesh regions.

Crushing olives in the south of France. The mill stones, weighing nearly 3 tons, are driven by water power

The importance of olive oil production is not however, strictly proportional to the number of olive trees; the height of the trees and yield of olives per tree vary considerably in different countries and may range between 4 to 5 kg. from the small trees of Provence to 100 kg. and more from the old trees of parts of the North African regions. The table overleaf shows average production of olives and olive oil in France and in North Africa.

Agricultural importance

A disadvantage of the olive tree is that it takes a long time to reach the fruiting stage; certainly this is a serious drawback. All woody shrubs and trees require a certain time to elapse between planting and fruiting, but this is more accentuated in the case of the olive than for most fruit-bearing trees, since it is usually reckoned that 15 years at least will elapse before crops are obtained. Against this minor disadvantage, however, other quali-

AVERAGE PRODUCTION OF OLIVES IN FRANCE AND NORTH AFRICA

Country	*No. of olive trees in thousands*	*Average production in quintals (220 lb.)*	*Observations*
France	12,500	60,000	Yields vary from 30,000 to 80,000 quintals, according to season.
Tunisia	23,000	400,000	Potential production of 700,000 quintals in a good year.
Algeria	12,000	120,000	Potential production of 250,000 quintals.
Morocco	10,000	100,000	Capable of great increase.

ties can be set which make the crop of great agricultural interest.

Length of life

The olive tree is extremely long-lived, and apart from losses caused by irregularity or neglectful cultivation, harvests can be gathered from the same tree for centuries; this largely compensates for slowness in reaching the stage of fruiting. By contrast, peach trees fruit in three years but they must be grubbed up and replanted when they are 15 years old. In a century, therefore, it would be necessary to replant a peach tree six times and to wait, in the aggregate, for 18 years for it to bear, compared with a 100-year old olive tree which would still be in full production.

Adaptability to soil

The olive adapts itself to a wide range of soil types by reason of its astonishing polymorphy and great number of varieties. It thrives in deep fertile soils but it also grows and remains healthy in soil where other cultivation is impossible. Moreover, it is not badly affected by deficient soil drainage. Its resistance to drought is proverbial; in the woody mass of its trunk it can store sufficient reserves of moisture to carry it over long dry periods. Only extremely severe drought stops growth and only in exceptional cases does it cause death.

The olive is sensitive to lack of cultivation and responds readily to attention. When, however, it is left for years without attention, neither pruned nor manured and allowed to be over-run by weeds, it does not die and resumes vigorous growth when more favourable conditions are restored.

Single trees or entire olive groves can easily be reorganised by close pruning which promotes the growth of numerous shoots to replace deficient foliage.

If a sufficient supply of nursery plants to replace vacancies is not available, a cutting from the base of a tree of sound stock will give a healthy plant as early as the following year. The olive tree therefore, is highly adaptable and there is much to be said for olive cultivation in the South of France and its extension in the numerous North African territories.

Tillage improvements

Although the olive shows extraordinary rusticity, it does not follow that it must be treated like a forest tree and left to grow untended under natural conditions.

As mentioned, the tree is markedly resistant to drought and does better under dry conditions. The destruction of weeds, tillage and manurial dressings, besides having the usual biological and mechanical effects, ensures the penetration of moisture and conservation of soil.

Regular pruning is a necessary complement to cultivation since it regulates growth and the production of flowers. The habit of the tree facilitates the work of the pruner since every part above ground, if it is sufficiently old, is covered with dormant buds which can sprout if pruning is properly done. The flowers normally appear on two-year old wood and the whole art of pruning consists, therefore, in provoking each year the sprouting of a sufficient number of buds proportional to the age and vigour of the tree.

Grafting

Grafting is not indispensable, but it is usually necessary. In North Africa immense areas of wild olive trees have already been brought under cultivation by grafting, and the extension of the practice is obviously desirable. Even in France many varieties would benefit by being grafted.

All the usual methods of grafting can be used for the olive tree. For young trees, however, cleft grafting is preferable but for older trees patch grafting is more suitable.

Manuring

In North Africa, with few exceptions, the olive is at present not manured, but in France soil exhaustion generally makes a dressing of fertiliser necessary. Organic matter is indispensable and slow-acting forms are preferable; in addition chemical supplements are usually desirable. The table at the bottom of the page gives a typical standard treatment over two years.

This rate of application is desirable for small trees planted at 150 per hectare; for other densities the application varies proportionately.

Pests and diseases

The olive suffers from a number of pests and diseases. Among insect pests the olive fly *Dacus oleae* periodically causes trouble in France and may destroy entire crops. The control of this dipterous insect is difficult, and methods used include trapping and the use of insecticides such as DDT, etc.

The caterpillar of a moth (*la teigne*) which attacks flowers and floral clusters and also the fruits, can be controlled by spraying with arsenicals immediately before flowering.

Scale insects accompanied by black blight commonly occur on trees producing white olive oil.

Among the cryptograms (fungi), *l'oeil de paon* (peacock's eye disease), which causes defoliation, can be effectively treated with 2% Bordeaux mixture, and if it is applied in conjunction with lead arsenate provides protection against *la teigne* also.

Present position of the industry in France and North Africa

France. During the past half century the olive tree has gradually passed out of cultivation on land of high fertility and is now grown almost exclusively on poor soils where no other cultivation is possible.

To abandon olive cultivation would render 80,000 hectares sterile for not even forest trees grow in these rocky conditions and stunted wasteland vegetation would slowly succeed the olive. In Provence, wasteland is liable to bush fires which are followed by erosion. Accordingly, the

APPLICATION PER TREE

Organic manure		*Inorganic manure*	
First year:		First year:	
Farmyard manure	60 kg.	Muriate of potash	1 kg. (2.2 lb.)
or green manure	Vetches	Superphosphate	1 kg.
or oil cake (5% nitrogen)	5 kg.	Sulphate of ammonia ..	1 kg.
Second year: ..		Second year:	
None		Muriate of potash	1 kg.
		Super phosphate	1 kg.
		Sulphate of ammonia ..	2 kg.

continued maintenance of olive cultivation has great importance from the soil conservation point of view and is in fact indispensable in southern agriculture. Moreover, France is passing through a period of scarcity of oils and fats and so the rehabilitation of the olive groves, abandoned during the war, is a matter of considerable importance. Actually hundreds of thousands of olive trees have already been improved and production considerably increased and regularised as a result. Much more, however, remains to be done.

North Africa. The need for increasing olive cultivation is obviously the same as in France, and it is often even more important. The olive tree flourishes on the bare, unproductive soils of this region, for example the Tunisian Sahel, and it has brought prosperity to large areas of desert.

Tunisia. Before the war olive oil production in Tunisia was highly developed and plantations were expanding at the rate of millions of trees per year. The area is still increasing but since 1942, the country has suffered from a succession of severe droughts. For four years the rainfall in Southern Tunisia has been insignificant and consequently the crop has fallen to very low figures, production of oil being hardly sufficient to meet local needs (200,000 quintals), and the growth of many hundreds of thousands of trees has been affected.

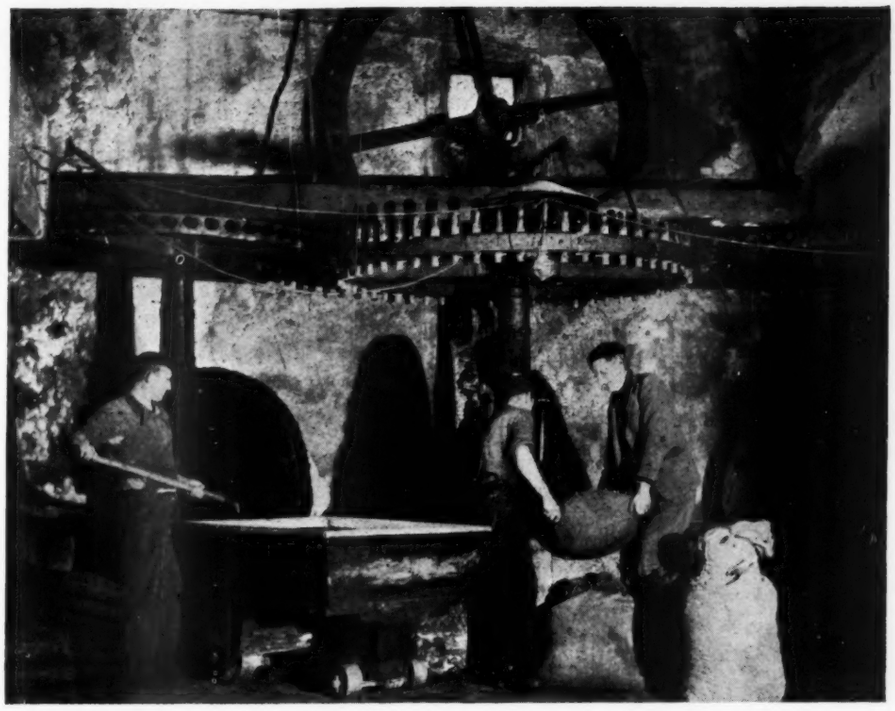
The resumption of better climatic conditions will doubtless revive the olive groves and allow them to resume the important position that they formerly occupied.

Algeria. Here the conditions of the olive groves is good and crops are sufficient to provide an exportable surplus after satisfying local needs. Among the older plantations, much improvement has already been made by grafting with improved strains and the work is being extended vigorously.

Morocco. Here also the olive groves are in full production. The plantations have received a good rainfall and harvests have been good. The yields of olive groves owned by indigenous proprietors could be greatly increased by improved cultivation and a start has been made with systematic plantings.

Production of olive oil

Comparatively little progress has occurred in the methods employed in extracting olive oil from the fruit. Just as in Roman times the usual procedure is to crush the olives under millstones, to squeeze the resultant pulp in presses and to separate the oil from the liquid coming from the presses by decantation. There are



The residues from the first pressing are sprinkled alternately with hot and cold water preparatory to a second pressing

mills in North Africa which resemble in every respect those of 1,000 years ago. In some of the more modern mills hydraulic presses have been substituted for the older forms operated by a screw or by ratchet levers, but the principal advance has been the introduction of centrifugal separation of the oil from the press liquor. The expression of oil has therefore remained a small-scale process and there is scope for great improvements in the manner in which it is conducted.

Apart from the possibility of introducing entirely new methods and techniques of extraction, upon which subject considerable research is in progress, many improvements could be made in existing installations and the manner in which the operations are carried out.

The impossibility of keeping olives in store for any length of time before they are treated has caused the industry to be carried on in a large number of small factories instead of a smaller number of centralised establishments. The seasonal character of the industry and the consequent difficulty of carrying the overhead charges during times when the extraction plant is not operating have been another obstacle. In Southern France there are more than 600 small mills which the co-operative movement is slowly grouping together. At the present time there are 80 olive oil co-operatives which are for the most part reasonably well equipped and efficiently operated.

In North Africa there are also a large number of small mills owned and operated by native producers, but there are also a number of European-owned mills which are well equipped and efficiently operated. Some of these only handle the produce of a single property, this is particularly the case in Tunis; others treat olives bought from other producers, while some are worked on co-operative lines; this prevails to an appreciable extent in Morocco.

If little progress has been made in methods of extracting olive oil, there has been remarkable improvement in the conditioning and refining of the product and the handling of by-products. Poor quality oils which formerly could not be used for food are now refined and help to increase the production of edible oil, although it is true that their nutritive value is considered to be lower than that of oils of first expression.

The press cake derived from the pulp after the oil has been expressed by the mill is now treated in extraction plants where the remaining oil is removed by solvent extraction. Oil obtained in this way is termed *huile de pulpe* and is most usually employed for industrial purposes.

Economic importance of olive oil

Before the war France held an important place in the international olive oil trade. In fact, notwithstanding that insufficiency of domestic production obliged her to import to satisfy internal needs, the high

reputation of French oils and the skill of the business men of Southern France caused her to take a leading place among exports to other European countries and to the U.S.A. During the years 1930-39 French trade in olive oil showed the following annual averages :

	Qx.
Production in France (metropolitan)	63,836
Imports	279,705
Total	343,541
Exports	131,789
Consumption	211,752

The imports came principally from Tunis, Algiers, Morocco and also from Spain and Italy. Exports went to the United States, Great Britain, Switzerland, the Argentine, Australia and elsewhere.

It seems probable that the producer countries will in the future try to market their produce directly without passing through French channels; but the best qualities of Provencal oil will, it may be anticipated, command a prominence in world markets for many years to come. Olive oil is and must remain a luxury product and on this account maintenance of quality is essential.

The French policy in regard to olive oil production is aimed primarily to satisfy home requirements, and produce from the exportable surplus high quality oils to meet the requirements of export markets.

On this basis the interests of French and North African producers are closely locked together from the economic point of view. Future prospects for the olive oils industry of France and her North African Dependencies seem to be favourable.

Protection of Orchards from Frosts

Spring frosts are a source of constant worry and anxiety to fruit growers. The risk of damage to the blossom or young fruit is ever present during April and May, and sometimes even in June. Some orchards are more prone than others to this damage, but none can be said to escape the danger entirely. This account of recent investigations carried out at the National Institute of Agricultural Engineering into the possibilities of protecting orchards from frost by the use of large diameter horizontal fans will interest all orchardists in the temperate regions.

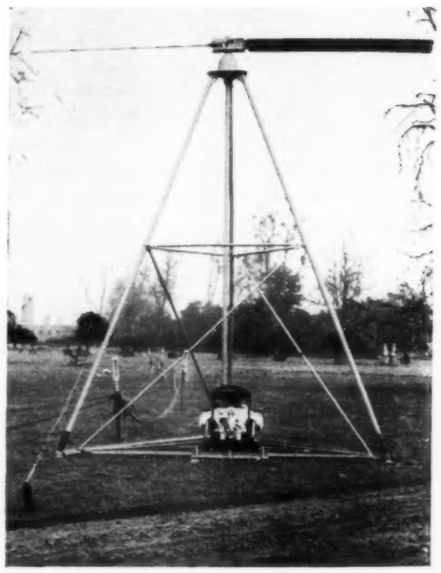
THE problem of maintaining the temperature of an orchard crop above freezing point is not easy to solve, nor is it the same problem for all conditions; the degree of protection required, the type of crop and its location are important factors to be considered when deciding upon measures with which to combat the danger.

Importance of location

It is now generally accepted that the type of location least susceptible to frost damage is on high land close to low land or a valley so that the cold air will flow down to the lower altitude. Provided the cold air is able to flow away from the orchard and is not obstructed by continuous perimeter walls or thick hedges, only light ground frost is likely to occur and will not last long.

At the other extreme of location, low-lying land, hard frost is likely to occur frequently during late spring and methods of protection are generally costly and sometimes impracticable. Spray irrigation is sometimes employed because water, having a high specific heat and large coefficient of fusion, gives up heat which may protect young fruit from damage. Chemical mists and smoke-screens are also sometimes employed to insulate the orchard area by providing a blanketing effect and, to some extent, protection.

Orchards are sometimes situated between these two extremes of altitude and although not so free from frost as the high land this may be compensated by the fertile soil. At these medium altitudes, when the descending cold air has filled the valleys, its level will rise above them if they are not large enough to hold it all. It is at these medium altitudes that mechanical methods of frost protection are most likely to be of use to growers.



The 20-ft. frost fan at Wrest Park, headquarters of the NIAE

Under these conditions direct heating methods have been found to be both uneconomical and unsuccessful since a rise in temperature of 4° F. is the most that can be expected from direct heaters. Low-grade radiated heat is a more promising method and can effect a rise in crop temperature of 8° F. The apparatus used consists of an atomiser oil burner with a heater tube that operates at dull red heat sending out infra-red radiation which is absorbed by the trees and the soil. A machine in this country with a heater tube 18 ft. high has been found to protect an area of one acre. With this method it is the temperature of the crop rather than that of the surrounding air that is affected.

Utilising the inversion layer

Another possible source of low-grade heat is the warm air at higher levels. Spring frosts usually occur during clear nights following clear sunny days. During the day heat from the sun is absorbed by the soil at a rate of 1,600 to 3,600 h.p. per acre, and if the soil surface is dry it becomes warm and radiates heat to the surface layer of air which, on becoming warmed, rises and allows cold air to become warmed in its place until all the air up to about 500 ft. above the ground is being warmed to some extent. Towards sunset heat reaching the soil lessens and the rate of heat being re-radiated from the ground exceeds that of heat being absorbed by as much as 900 h.p. per acre, so that the air in contact with the ground becomes chilled. Consequently there is a progressive rise in temperature from ground level to what is known as the inversion layer. The differ-

The 30-ft. frost fan at Melbourn, Cambs., in a Bramley orchard

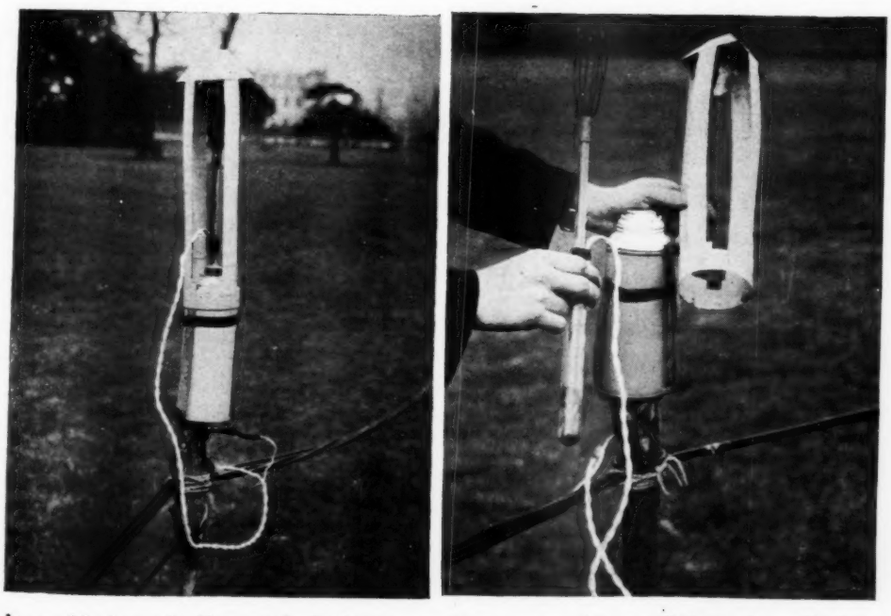
ence between ground level temperature and that of the inversion layer may be more than 10° F., and a method of mixing the warm ceiling air with the cold surface air may provide a suitable solution. This has been tried out in America and Australia by using large horizontally rotating propellors to draw down the warm air. The American experiments resulted in a satisfactory protection of 22 acres by using aircraft propellors mounted on a tower and driven by powerful engines of about 90 h.p. In Australia a 10 h.p. engine was used to drive a propellor of 30 ft. diameter and results were satisfactory.

A similar propellor only 20 ft. in diameter powered by a 10 h.p. engine and running at 120 r.p.m. was constructed by the NIAE and produced a rise in temperature of between 2° F. and 6° F. over an area of one acre.

Frost damage

Frost damage seems to be caused by ice forming in the cells and indirectly causing dessication, which may depend upon the rate of thawing of the tissues. It is the softer parts of the bud which appear to suffer most readily and it is these parts which contain most sap. Now the damaging air temperature is frequently only a couple of degrees F. below the danger level which makes possible and justifies the use of wind machines for the work of protection.

The main disadvantage of high speed air circulators such as were used in America is their very high cost and a large low-powered fan moving a very great volume of warm air relatively slowly would be more economical and efficient in operation and would also require a smaller capital outlay, since it can be made more roughly and cheaply than a high-speed machine.



Assembled and dismantled thermometer; note the roof-shaped radiation shield. The cold junctions are placed in the thermos flask containing iced water

NIAE investigations

The investigations of the National Institute of Agricultural Engineering were carried out with two fans. The first had a compressed laminated spruce blade 20 ft. in diameter with a 15 in. chord and a 140° angle of attack, both constant along the blade. The fan was supported on a tubular steel tripod 20 ft. tall, mounted in a base to which the driving engine and gears were fixed. The engine used was a twin-cylinder horizontally opposed air-cooled motor rated at 12 h.p., connected through a flexible coupling to a hand-operated car clutch and gear box, the latter being useful for relieving the accelerating strain on the blade. The fan revolved at one-tenth of the engine speed in top gear.

The second fan had a 30 ft. diameter and laminated mahogany was used in this case. It was tapered and curved so that the angle of chord and attack varied along the length. A heavy pyramidal frame of angle iron 30 ft. high was made for this fan so that the whole would be maintained firm and stable by its own weight. The fan was bolted to a three-wheeled trolley which rotated between steel plates; these plates took the weight when the fan was at rest and the vertical thrust when it was revolving. In this case a medium-powered tractor was used to drive the fan through a long (50 ft.) 6 in. belt, which was suspended almost vertically between the tractor pulley and a pulley driving the pinion of a 4:1 bevel reduction gear to which the fan shaft was attached. The tractor (26 h.p. at full power) was almost faltering when driving the fan at 170 r.p.m.

The fans were erected near the bottoms of very shallow basins about 300 ft. deep and three miles wide, and the sites were chosen for their flatness and uniformity.

Measurements recorded

The preliminary aim of the experiment was to measure changes in air temperature

when the fan was started and distant reading electrical thermometers were laid out at varying distances from the fan. At the side of each air temperature thermometer was a bud thermometer. Thermometers were erected 5 ft. from the ground at 10, 20, 30, 45, 60, 75 and 95 yards from the fan along each of the four radii running N.W., S.W., S.E. and N.E. approximately.

The temperature distribution round the fan was not sufficient to indicate its performance and measurements had to be taken of the two affecting factors; the strength of the inversion and natural wind. The inversion strength indicates the rate at which air temperature increases with the distance from the ground. This was measured by suspending thermopiles of the type used on the ground from the cable of a captive balloon. Thermometers were placed at 5 and 10 ft. on a post and at 25, 50, 100 and 150 ft. on the balloon cable.

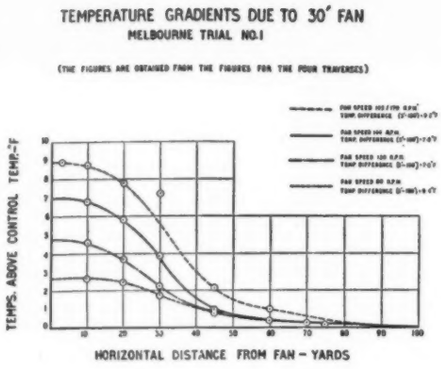
Normally there is little wind on nights of frost and wind velocity measurements during the spring of 1949 did not show a higher speed than 3 m.p.h. on frosty nights.

Results

Temperature measurements were made at approximately half-hourly intervals throughout the night.

It was possible to vary the speed of the larger fan and it was found that higher speed resulted in an increased range of protection. It was also found that the effectiveness of the fan was improved by an increase in the strength of the inversion.

The smaller fan caused a rise in temperature of between 2° F. and 5° F. over an acre of bare lawn. The 30 ft. fan caused a rise of as much as 8° F. under the fan dropping to 2° F. at the rim of a circular area of an acre and a half and its effect was still measurable at 80 yards (equivalent to four acres).


TEMPERATURE GRADIENTS DUE TO 30' FAN
MELBOURNE TRIAL NO.1
(THE FIGURES ARE OBTAINED FROM THE FIGURES FOR THE FOUR TRAVERSES)
TEMPS. ABOVE CONTROL TEMP.-F
HORIZONTAL DISTANCE FROM FAN - YARDS

The cost of running the larger fan compared with that of employing heaters to give a similar rise in temperature was small; 6 gal. of TVO were used to run the fan whereas the amount of oil required for heaters would be nearly 300 gal. (100 heaters—3 gal. apiece).

A summary of the results is as follows:

(1) Under suitable conditions a frost fan provides a method of raising the air temperature between 3° F. and 8° F. in an acre of orchard at an almost negligible operational cost.

(2) The fan is most efficient under conditions obtaining when a radiation frost is most probable.

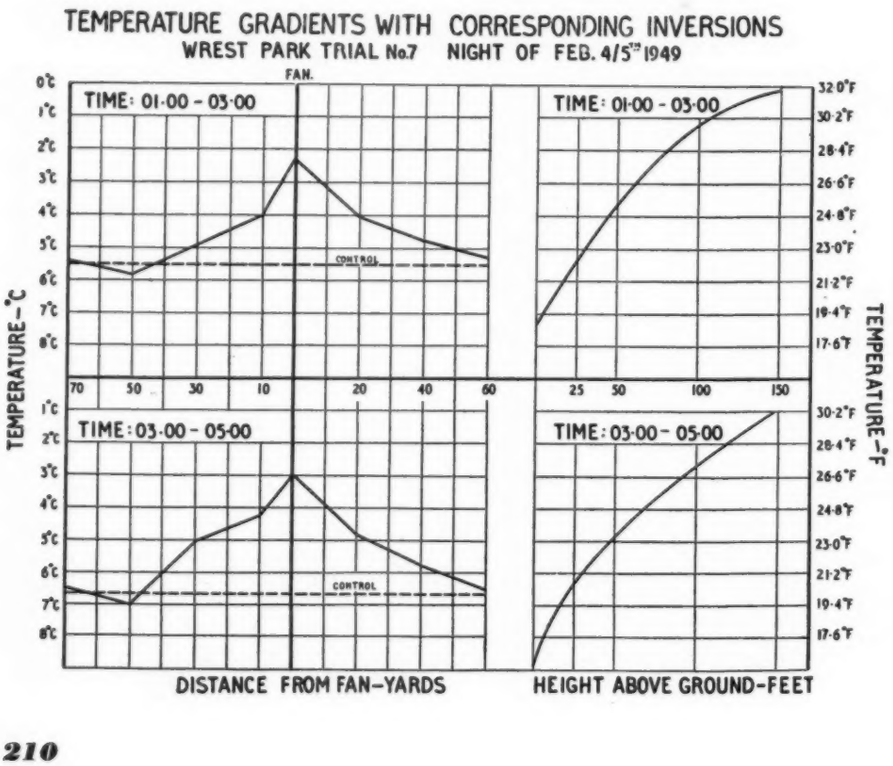
(3) The fan would have relatively little effect in a wind-borne frost.

(4) The fan would have little effect in a weak inversion and it would be necessary to add heat artificially.

(5) The action of the fan appears to cause the bodily replacement of cold air by warm air rather than the mixing of cold and warm air by turbulent motion.

These are the results of the preliminary investigations carried out by the Horticultural Group of the NIAE during the autumn of 1948 and spring of 1949. The capabilities of the fans are not yet such that these units can be considered for commercial work, but work is still going on to augment the data already accumulated in order to improve the fan's performance, to correlate accurately temperature gains with increase in crop yield and to improve temperature measuring technique. There is hope that more economic units will be constructed and that growers may ultimately be able to benefit from this novel method of frost protection.

(*Photos: National Institute of Agricultural Engineering.*)



Spain's Five-Year Plan

The Spanish Ministry of Industry and Commerce has issued a long statement giving details of new plants, or extensions of existing installations, which will begin operating in 1950 or 1951 as part of the five-year plan for the industrialisation of Spain. The plan consists of four main divisions:—the agricultural industry, transport, the production of basic raw materials and the manufacturing industry.

Under the first part of this plan new plants or extensions of existing factories built or to be built in the country will allow for the following increases in fertiliser production:—150,000 tons of sulphate of ammonia, rising to 280,000 tons per annum by 1951 or 1952; nitrate of lime, 32,000 tons rising to 64,000 tons; calcium cyanamide, 6,000 tons; mixed nitrogen, 74,000 tons per annum.

Plants at Valladolid and Zamora will treat between 800 and 900 tons of sugar beet each per day for the production of sugar. Refrigeration facilities are to be installed or extended in Cadiz, Malaga, Murcia, Granada and Logrono, and refrigerated road and rail transport will be improved.

Expansion in the manufacturing industry will include production of Diesel caterpillar tractors in Barcelona, while another factory will be set up near Madrid. Light-wheel tractors are to be built in Seville.

The Sugar Cane

A. C. BARNES, C.M.G.

Director of Research for the Sugar Manufacturers' Association (of Jamaica) Ltd.

The sugar cane is the most important source of the world's sugar supplies. This article provides a summary and review of the world position in this regard. In subsequent issues it is hoped to review some of the more important cane sugar producing countries.

SUGAR cane, a giant member of the grass family, is the most important source of cane sugar or sucrose, itself one of a large family of sugars. Sugar cane is responsible for the world production of more than 20,000,000 tons of sucrose annually and is widely grown as a plantation crop throughout the tropical and subtropical regions. Known botanically as *Saccharum officinarum*, again one of many species of the genus, it provides the cheapest form of energy-giving food with the lowest unit of land area per unit of energy produced. Although sucrose alone is not a diet on which man can live it represents about one-seventh of the total energy intake of human food for a normal person under non-restricted conditions of supply. It has been stated that an average man's annual food consumption is equivalent approximately to one million calories. Under present agricultural systems this is produced by one-eighth of an acre of sugar cane, while whole wheat flour requires 7 times, milk 20 times and beef over 100 times as much land to produce the same amount. These striking facts serve to emphasise the importance of sugar cane as a source of food, but consideration of the numerous other direct and indirect products derived from the cane gives an even more impressive conception, since apart from its varied uses as a food and sweetening agent, sucrose is extensively used in the arts and manufactures, while it is coming into increasing prominence as a raw material for the production of a variety of important chemicals including such diverse products as refrigerants and drugs.

The residues of cane sugar extraction yield still more raw materials used in manufacture. The exhausted fibre (bagasse or megass) consists largely of cellulose and is used for making compressed fibre board, paper and cattle food. The dark, sugary syrup remaining after the factory process has separated the recoverable sucrose, known as molasses, is a source of alcohol both as potable spirit (rum and gin) and for industrial use, as well as bakers' yeast and dry ice. During recent years it has come into prominence for the manufacture of food yeast, rich in protein and vitamins. A valuable wax, found on the outer surface of the cane can be extracted from the mud separated from the juice in the sugar factory process.

Cutting the cane in Jamaica

Discussion of the wide range of uses and products of sugar cane is beyond the scope of an article intended to be descriptive of the sugar cane as a world crop, but sufficient has been said to indicate beyond doubt its high ranking importance in a long list of economic crops.

Historical

The sugar cane has been known from the earliest times and is referred to in historical records going back into the remote days of ancient civilisations which flourished long before the Christian era—though the actual extraction of sugar from it does not appear to have been discovered until much later.

It is now agreed that the original home of the sugar cane is the islands of the Pacific region from whence it spread to other parts of the world. It spread first to the Asiatic mainland, notably to India, to the southern parts of China and adjoining countries, where the manufacture of sugar or a sugary product from it first originated. From there it spread via Persia and the countries of the Middle East to the Mediterranean region, including North Africa and Egypt, as well as some southern European countries, notably Italy and Spain; in Egypt and southern Spain sugar cane cultivation is still an important industry, but in the others it has died out.

Columbus seems to have been responsible for the first introduction of sugar cane to the islands of the West Indies in 1493, though it was not until a few years later that the crop was successfully established in Hispaniola where sugar was made in 1509. From there the crop became distributed throughout the other islands of the West Indies, to the southern States of North America and to many countries in the South and Central American region.

In Jamaica at the time of the English conquest in 1655, there were three small sugar plantations. The first English plantation there, owned by Sir Thomas Modyford, made sugar in 1664. The sugar industry seems to have developed steadily in the 18th century, and in 1789 there were 710 sugar plantations in the Island and two years later the number had increased to 769. The record output of this earlier period was in 1805, when the yield was 120,280 tons. Other territories of the British West Indies have similar records. Sugar cane has been the principal crop of Barbados for more than 250 years, and of Antigua since 1671. In British Guiana the first horse operated mill was erected in 1664, and production in the 1820s approximated 60,000 tons of sugar annually.

The story follows somewhat similar lines in islands as far distant as Hawaii and Mauritius, in both of which the crop was being grown in the 18th century. More recent cane sugar producing countries are Australia, Fiji and South Africa. Cuba, in the latter years of the 18th century, contributed some 15,000 tons of cane sugar to

world trade and reached 1,000,000 tons 100 years later, the present-day output being about 6,000,000 tons.

In Java, under Dutch influence, sugar cane cultivation expanded enormously during the 19th and early 20th centuries, and in the years before the last war reached approximately 3,000,000 tons, while under Japanese influence sugar production in Formosa attained the million ton mark.

The list is not exhaustive nor is the narrative complete, but it gives an indication of the history of a crop which has swayed the destinies of whole peoples and has played on many occasions a dominant part in inter-territorial policies and even in wars.

Sugar and politics

The industry has experienced many and violent disturbances with fluctuations in output and profit resulting from political changes, trade problems and war. In many parts of the world, particularly in the Caribbean area and Louisiana, the slave system on which the planters relied for their labour offended the outlook of right-thinking people and its abolition at various times in the different countries caused a temporary setback in production. The American Civil War brought about developments in Cuba and Hawaii, and the Spanish-American War while adversely though temporarily affecting Cuba, caused expansion in Puerto Rico and the Philippines. The sugar bounties of the late 19th century, abolished in 1903, profoundly depressed the British West Indies and special forms of assistance had to be devised to revive the industry.

Sugar cane cultivation

Sugar cane is propagated vegetatively, that is by the planting of portions of the growing cane which normally reproduces itself without change in this manner. Very occasionally bud sports appear, different from the parent, giving rise to new varieties, some of which have proved to be of commercial value. Under plantation conditions from seven to twelve acres of young cane are planted from an acre of young immature, but vigorous cane, which is usually cut into seed pieces or setts of two or more 'joints.' At each joint or node is an eye which gives rise to the new plant and embryo rootlets which provide its root system. There are various methods of planting depending on local conditions of soil, climate, labour and the extent to which machines are used. Planting methods as well as the varieties of cane grown have changed from those used in earlier times and are still changing.

Under favourable conditions of moisture and temperature the bud sprouts give rise to a rhizome which develops its root system and produces aerial shoots or tillers so that as growth proceeds a number of canes develop, having originated from one eye of the original seed piece.

Soils

Cane soils may vary from the highly organic types, characteristic, for example, of the everglades of Florida, to heavy clays. The sugar cane flourishes best in a rich, medium loam with ample rainfall, though it is successfully grown in fairly low rainfall areas, where other conditions are favourable, without irrigation. Where adequate supplies of water are available and natural rainfall insufficient it flourishes under irrigation. Of recent years there has been some development of overhead irrigation systems simulating rain. The crop responds to the correct applications of artificial fertilisers as well as to organic manures in the form of farmyard manure or sugar factory residues such as bagasse and filter mud. It seems probable that the crop may itself act as a soil improver as do other members of the grass family; instances exist of sugar cane having been grown continuously on the same land for over 200 years with no decrease of, and indeed increases of yield under modern systems of crop management. Occasional instances arise, as in the organic soils of Florida, where minor elements are deficient, and where small applications of salts of copper, manganese and zinc are essential.

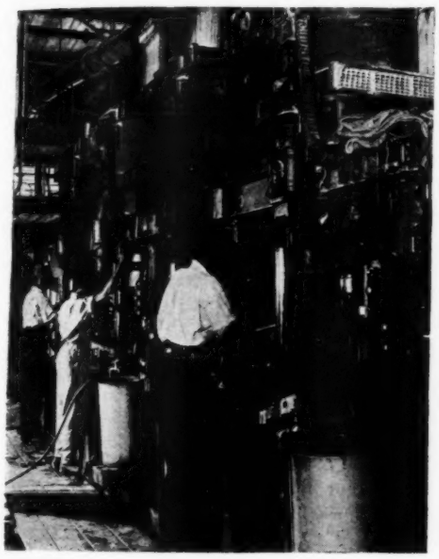
Each sugar cane area, however, provides a study in itself, and considerable variations in the behaviour of the sugar cane will be found from field to field on one plantation or even between different parts of the same field. Not only do methods of cultivation and treatment require to be specially adapted to the soil conditions obtaining on the spot, but varieties of cane have to be selected in relation to environmental factors.

Sugar cane varieties

Certain varieties of cane produce seed freely, but as a general rule special conditions are necessary for the cane to reproduce itself in this way. Cane is not commercially grown from seed and the appearance of the flowering head or arrow is no indication of the vigour or productiveness of the crop but rather evidence either of conditions which stimulate the cane to reproduce itself by the production of seed, or it may be a characteristic of particular varieties which seed freely. It was for long thought that the sugar cane did not produce fertile seed, although it now seems certain that in the past new varieties have almost certainly arisen through the accidental germination of cane seed under field conditions. The demonstration by Harrison and Jenman in Barbados, and independently by Soltwedel in Java, in 1889, that under suitable conditions cane

Harvesting on a Jamaican sugar plantation

seed would germinate has exercised a profound and even revolutionary influence on the cane sugar industry inasmuch as it has made it possible to produce new varieties of cane under controlled conditions which are superior to those previously cultivated. For the past 60 years organised work on an ever increasing scale has been conducted on the production of new seedling varieties. In the earlier stages this was confined to growth of seedlings derived from the varieties actually in cultivation, but the work of Jeswiet in Java and of Barber in India in the 1920s showed that it was possible to hybridise these so-called noble canes with more

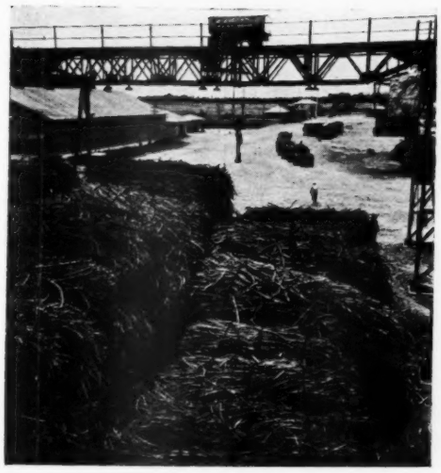


Battery of centrifugals for separating sugar from molasses in the masse-cuite

vigorous closely-related species, thereby introducing new genetical factors and enabling the production of new canes possessing greater vigour, improved productive power and enhanced resistance to disease.

As a result all over the world yields of sugar per acre have been greatly increased and in some countries, under favourable conditions, yields of upwards of 10 tons of sugar per acre have been obtained.

The work is of a highly-specialised nature and can only be conducted with success in places where certain sugar canes flower freely. Special cane breeding stations have been set up in many of the cane-growing countries with the object of breeding new varieties of cane possessing such special characteristics as higher yielding capacity, resistance to pest and disease and suitability to particular environmental conditions. At these stations various types of wild and cultivated canes are grown for the special purposes of breeding work. One



The yard of a sugar mill showing bundles of cane delivered in the yard and awaiting transport to the conveyor by overhead crane. In the background can be seen a tractor hauling loaded trucks

which serves the British Caribbean area and certain other contributing territories has been in successful operation in Barbados for many years. Thousands of new seedlings are produced each year and from these selections are made from successive generations propagated vegetatively until new and promising canes possessing the desirable characteristics have been chosen for commercial trial, in the course of which further elimination takes place.

Pests and diseases

The sugar cane is susceptible to attack by numerous pests and diseases, all of which are liable to affect the growth and yield, and some of which may, if left uncontrolled, bring about the failure of the crop. Thus the Bourbon cane which had been the mainstay of the industry in the Caribbean for a century showed signs of failure from a rind disease and disappeared as a commercial cane in the earlier part of the 1900s. It is curious that different cane-producing countries experience quite different effects from pests and diseases. Jamaica is outstanding in the British West Indies in regard to mosaic disease, which causes a mottling of the leaf, destruction of some of the chlorophyll and, with some varieties of cane, a stunting of the growth. In Barbados, Trinidad, Antigua and St. Kitts, the disease is rarely if ever noticed and causes no anxiety to the planter. Froghopper is a very serious pest in Trinidad and to a lesser extent in British Guiana, but it is not on record as having caused trouble elsewhere. In Fiji and Hawaii a so-called Fiji disease of cane occurs and breeding for resistance to these diseases is a feature of the programme for producing new seedlings. Moth borers of cane are of widespread occurrence. The entirely opposite experience of the extent of damage by this pest in Jamaica and Barbados is of interest. In the former place the borer is under natural control and causes negligible damage whereas in the latter a special organisation has had to be set up for breeding parasites for the control of the pest, which are distributed throughout the island each year and sent to adjoining territories where similar conditions occur.

Maturation period

Cane planted in the fall of the year normally matures under fully tropical conditions in about 16 months, but in some places, for example Hawaii, it is allowed to continue growing for periods ranging from 24 to 48 months with a corresponding increase in tonnage reaped and sugar recovered. Cane planted in the spring in the West Indies is normally reaped 12 to 14 months later. Under favourable conditions of soil and climate the cane can be grown for extended periods as in Hawaii, but there are objections under West Indian conditions to this practice though investigations are now being made in regard to the possibility of growing canes capable of remaining for longer periods before being reaped.

After the standing cane has been cut succeeding crops will grow without replanting when conditions are favourable. Again soil and climate determine the number of succeeding crops, known as ratoons, which can profitably be raised from the same original plant. Ratoon crops range from as low as two to nine or even more under exceptional conditions. It is recorded by a cane planter of the 18th century that his plantation in the east of Jamaica gave six ratoons whereas another one owned by him in the west produced only two or three at the best. Those conditions apply to the same areas today despite changes in cane varieties and land management methods.

Research

Research has played a very important part in the development of the industry and has made major contributions to improvements in cultivation practice, economic use of manures, improvements in sugar yield and in factory economy. Reference has already been made to the breeding of new seedlings which forms a part of the research programme of many cane producing countries. In many instances research organisations are financed by the industry and there has been an increasing tendency in recent years in the West Indies in this direction. Investiga-

Vegetative propagation of sugar cane by planting portions of the growing cane

tions are not confined to field problems, though it is there that the greater opportunities for improved economy and increased yield occur. Technological research appears to have advanced at a greater rate than agricultural research and although much remains to be done in the study of the actual constituents of the cane and of its products and by-products, factory extraction processes have attained high efficiency.

Among research stations which have obtained world-wide fame may be mentioned the Experiment Station of the Hawaiian Sugar Planters' Association in Hawaii, the Proef Station at Pasoeroan in Java, unfortunately destroyed as a result of the Japanese invasion, and the Audubon Park Research Station in Louisiana; in British territories must be included the cane-breeding station already mentioned in Barbados, the Sugar Technology Research Branch at the Imperial College of Tropical Agriculture in Trinidad which is now being greatly extended and enlarged, the Mauritius Sugar Experiment Station and the Sugar Cane Research Organisations in Queensland and South Africa. All of these have made and are making notable contributions to the improvement of the sugar industry.

Economic factors

An account such as this would not be complete without reference to economic factors affecting the industry and its general outlook for the future. The cane sugar industries of the world have experienced major upheavals brought about by the second world war. The international sugar agreement which was operative at the outbreak of war fell into abeyance though nominally it was still effective. Java and the Philippines were overrun by the Japanese with disastrous results to their sugar production from which they will take many years to recover. In the British West Indies the policy dictated by His Majesty's Government swung almost overnight from restriction to all-out production, which has resulted in a remarkable increase in annual sugar production.

Colonial sugar

The urgent need for restricted hard currency expenditure on the part of Great Britain appears to put Dominion and Colonial sugar-producing areas in a strong position, and this has undoubtedly assisted in the rapid increase of sugar production during the past few years. During the whole of the war period Colonial sugar purchased by Great Britain has been subject to price control and the speculative position which arose during and after World War I was not repeated. The present arrangement is that Great Britain purchases all Colonial sugar available for export until the end of the 1952 crop, the price being negotiated from year to year.

(*Photos: Tate and Lyle Ltd.*)

Ammonia as a Fertiliser

The main response in the sugar cane fields of Louisiana is to nitrogen, and by far the larger area is fertilised by nitrogen alone. In 1947 a last-minute cancellation of the orders for nitrogenous fertilisers took place and attention was directed to an earlier experiment, carried out at Elm Hall Plantation, in which aqueous ammonia had been successfully used. At the meeting of the American Society of Sugar Cane Technologists, held in June last, E. A. Maier described the developments which have followed from that early experiment.

Anhydrous ammonia is probably the cheapest form in which nitrogen can now be obtained. It is also cheaply applied, though some expense must be incurred for equipment capable of handling and distributing it. The paper is mainly devoted to a description of that equipment, which differs according as aqueous or anhydrous ammonia is employed.

Aqueous ammonia is obtainable as 31.1% NH_3 by weight, and is kept under 6 to 10 lb. pressure. This is diluted to 23% ammonia, at which strength it will not build up pressure below 100°F. The Tennessee liquid fertiliser distributor is used for application, having its parts adapted to resist the action of ammonia.

Anhydrous ammonia offers problems both in storage and use. Storage tanks should have a working pressure of 250 lb/sq.in. Tanks for transfer to the field of about 1,000 gall. water capacity, and tractor tanks conveniently of 110 gall. capacity, are needed. Operators should wear gas masks and an ample supply of water must be kept handy in case of accidental contact. In spite of these disadvantages, trials carried on to a field scale in 1948 have shown them to be of minor importance and, of both forms, confidence is expressed that they will be found to be less expensive in application than fertiliser in the dry form.

It is too early to give specific results, but two points are indicated. It is important that the soil should be in a good state of tilth with ammonia in either form covered to a depth of 6 to 7 in. to prevent loss by evaporation. Their use will, therefore, give an urge to good cultivation. Also it seems safe to say that the results, measured in sugar per acre, have been satisfactory.

Further information is to be found in the *Bulletin* of the Mississippi State College, 'Ammonia as a Source of Nitrogen' and in 'Ammonia—its Uses and Properties' (Commercial Solvents Corp.). The distributor is described in Circular 87, University of Tennessee.

(*International Sugar Journal*)

Land Use and Conservation in Japan

C. L. W. SWANSON

Chief Soil Scientist, Connecticut Agricultural Experiment Station

Japan is often referred to as a country in which soil conservation and good land use is practised to its maximum, and one obtains the erroneous idea that in no area of Japan does soil erosion exist. This article briefly discusses land use practices and soil erosion in Japan, especially as they pertain to the uplands of that country. The author was formerly head of the Soils and Fertilisers Branch, Agriculture Division, Natural Resources Section for the Allied Powers in Tokyo.

JAPAN is a mountainous country, a solid backbone of mountains running through each of the main islands. About 75 to 80% of the area is hilly or mountainous land. Many of the mountains rise to heights of more than 8,000 ft., there being 18 important peaks of such heights, including Fuji-San with an elevation of 12,396 ft. The streams are short and rapid. The rugged relief is one reason why large areas of fertile soils are not found in Japan. The slopes are too steep to allow the formation of deep, relatively fertile, productive soils.

Along great stretches of the coast plains are absent and the hill lands reach down to tidewater. Numerous small plains occur in the mountain basins. The typical coastal plains are small, rarely extending more than 30 miles inland; the most important of these is the Kwanto (or Kanto) Plain comprising an area of about 3.5 million acres, on which Tokyo is located.

The new alluvium forms the genuine lowlands of Japan. They exist at a lower level than the ' diluvial ' benches and terraces and geomorphologically are comprised of fans, floodplains and deltas of new alluvium. Volcanic ash mantles much of the alluvium, as well as the ' diluvial ' terraces.

A typical arrangement of coastal terrain topography in Japan, from the sea to the hill land and mountainous areas, is as follows: (*a*) beach ridges and dunes, (*b*) alluvial plains, (*c*) ' diluvial ' terraces, (*d*) fan of ' diluvial ' material, and (*e*) hill land and mountains with numerous intermontane basins.

Climate

The climates of Japan are a mixture of continental and marine elements, the former predominating. Factors that influence the climate of Japan include the wide variation in latitude between the northern and southern extremes, the monsoons, the ocean currents, topography, and the proximity to the mainland of Asia. The country is warmer than the corresponding latitudes of the Asiatic continent, but colder than Mediterranean regions on the same parallel of latitude. Summer conditions are similar to those in the northeastern and middle Atlantic states of America, but the winters are colder, and at all times the humidity in Japan is higher. The growing season ranges from about 120 to 130 days in central and eastern Hokkaido to 250 days or more in southern Kyushu.

No part of Japan suffers from a yearly deficiency of rainfall, but occasionally droughts occur. There are no winter-dry climates. In general, rainfall increases from north to south, the figures for the entire country ranging from 30 to 100 in.

Vegetation

Originally, Japan was a wooded country and even today about 60 to 65% of the total land area is classified as forest land. Broadleaf forests consisting of oak, beech, maple, ash, chestnut, elm, cherry, birch and aspen types predominate, occupying about 40% of the total forested area; coniferous (cedar, cypress, red, black and white pine, larch, fir, spruce, hemlock) and mixed forests are about equally divided, occupying 24 and 23% respectively. These forests have a dense undergrowth, reflecting heavy rainfall and high temperatures during the growing period, and dwarf bamboo (sasa) is widespread on the forest floor. In the extreme southern part of Kyushu are found numerous tropical trees and vegetation, such as palms and banana trees. Many of the river valleys in northern and eastern Hokkaido are wet, tundra-like areas.

Altitude exerts an influence on the kinds of trees growing in Japan. Three general latitudinal forest zones, the warm (subtropical), the temperate, and the cold (boreal), are recognised.

About 12% of the land is in pasture and genya land. The term ' genya ' is translated in various ways—wild land, wasteland, prairie, meadow, pasture—but essentially it is treeless land, most of which will revert or be planted to forest. There are no areas of prairie as are found in the United States and Russia.

Soils, crops and erosion

The most important and most fertile soils of Japan, which support the bulk of the population, are the alluvial soils developed in the lowlands. On these paddy or irrigated rice is grown during the summer, and in southern Japan during the winter months they are also cropped to wheat or barley.

Many of the important agricultural soils are developed on volcanic ash. Ando soils, derived principally from volcanic ash materials and found in all areas of Japan, are important upland soils used for crop production purposes, but, since these are especially low in available phosphorus, they are comparatively low in inherent fertility. They are physically well suited to growing small grains, white and sweet potatoes, vegetables, mulberry, upland rice, tree fruits, tea, tobacco and other non-irrigated crops.

In many of the red and yellow podzolic soil areas (southern one-third of Japan), because the demand for cropland is so great, a large number of the steep slopes poorly suited to agriculture are terraced and cropped. The crops grown are wheat, barley, rice, white and sweet potatoes, vegetables, and, in many places on southern slopes facing the sea, citrus fruits are grown.

Most of the grey-brown podsolic soils, which are developed in the hill and mountain areas of northern Honshu and Hokkaido, are forested. Where these soils are deep enough, farmers have either terraced them or planted the row crops up and down hill without the benefit of terraces, and here soil erosion is quite severe. White potatoes, tree fruits, vegetables, small

grains (wheat, barley, oats), corn, and hay are the upland crops grown on these soils. No typical podsols are found in Hokkaido, although podsols might be expected because of the latitude and prevalent forest vegetation in this part of Japan.

Lithosols, which occur in the strongly hilly areas and in mountainous regions, are not well suited to crop production and are mostly in forest vegetation.

Erosion is also active on many of the non-arable hilly and mountainous areas of southern Honshu, Shikoku and Kyushu. Some areas, especially in the red and yellow podsolic soils areas, are practically devoid of vegetation and are badly gullied. Some of the land has lost considerable surface soil by sheet and rill erosion. Wind erosion is active on the Ando soils during certain seasons unless precautions are taken in the cultivations of these volcanic ash-derived soils. Clear-cutting practices on many forest lands leave large areas of land susceptible to sheet erosion. Another factor which increases the erosion hazard is the large area (7,190,000 acres) recently estimated (April 1948) by the Japanese Bureau of Forestry in need of reforestation.

The use of land for pasture and forage crop production has received relatively little attention in Japan. Pasture and harvested forage are largely what nature supplies and little research has been done on the production capabilities of soils and crops for pasture and forage crop purposes. It is known, however, that land exists in Japan which could be properly used for pasture and forage crop production. One Japanese scientist has estimated that 4,900,000 acres of land now in grassland, mixed brush and thin forest might be used for grazing. Although this probably is a large figure, proper renovation of suitable land to productive pasture and forage crop land not only would increase the potential food supply of Japan, but would tend to decrease the erosion known to be present in many of these areas.

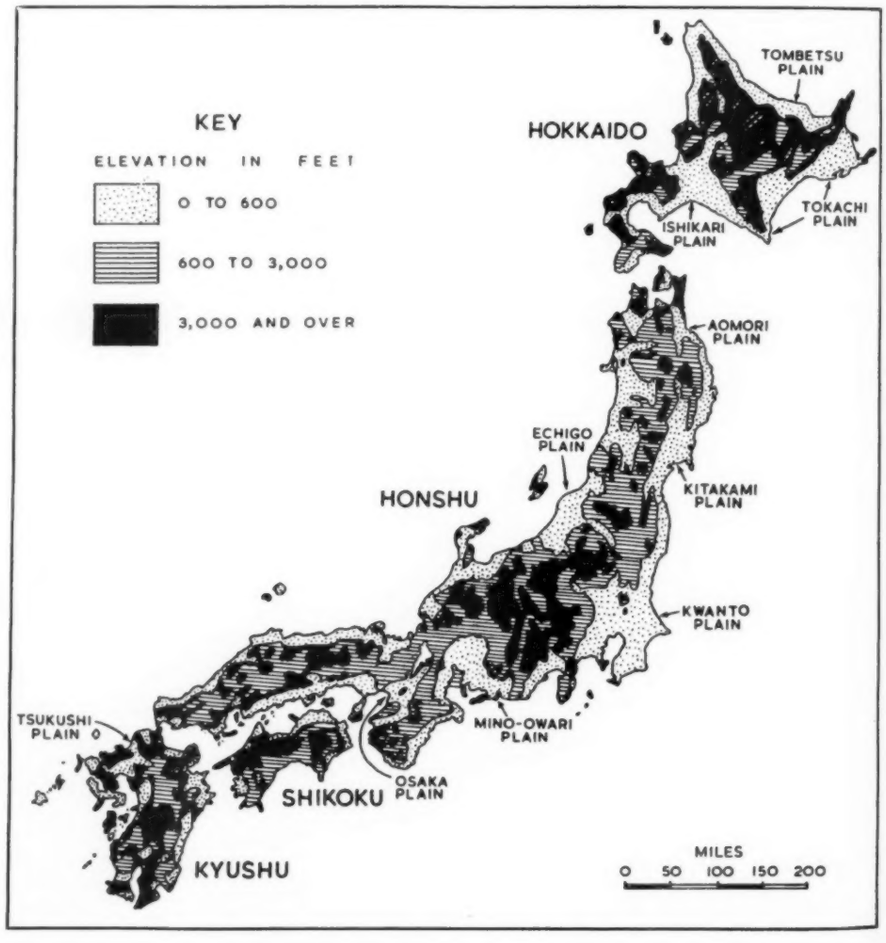
Cropping and fertilising patterns

The farm land of Japan falls into two main groups: rice fields (irrigated land) and upland fields (non-irrigated land) which are devoted to other crops. A little more than half of the cultivated land is in paddy rice; barley (both covered and naked), wheat, white potatoes, sweet potatoes, vegetables and fruits are the important upland crops. On a large part of the land two successive crops are grown each year. Two crops of rice are rare, but much of the irrigated rice land is replanted (double cropping) to winter crops, such as wheat or barley. Multiple cropping of land is practised widely in central and south-western Japan and a succession of an early vegetable, a late vegetable or buckwheat and wheat or barley is common on the upland areas. Because of this practice the area of cropped land is nearly 40% greater than the area of arable land.

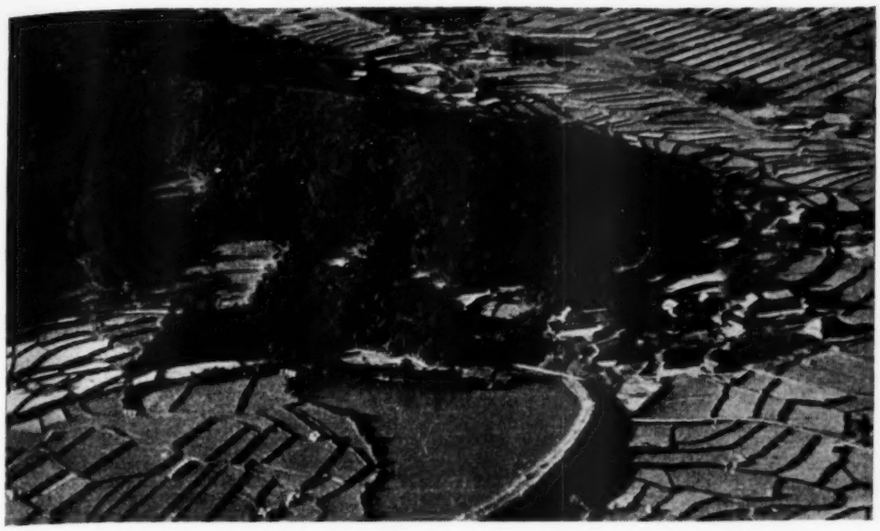
For maximum crop yields most of the soils of Japan require heavy fertilising and liming. Fertilisers are of real importance because of the intensive agriculture and because the scarcity of agricultural land makes it important to secure high yields from every crop grown. Because large amounts of commercial fertilisers, farmyard and green manures, composts and night soil have been applied to crops the soil fertility trend on agricultural lands is improving.

Increase of arable land area

The area of Japan is about 147,000 square miles and on this area live about 80,000,000 people; a density of 540 persons per square mile for the total area, or 5,330 persons per square mile of cultivated area. The preponderance of hilly and mountainous terrain sets definite limits to the cultivated area and explains why no more than 15 million acres, or 16% of the total area of Japan, is cultivated. On this land area the farmers of Japan have provided 80 to 85% of the annual food requirements for their country during the past 20 years. With increased demand for food due principally to a rapid rise in population (69,000,000 as the 1931-1940 average), it cannot be expected that Japan will produce sufficient food now to feed her people. There is still some land, however, that could be put into crops and the Japanese Government has a plan for the reclamation of 3,900,000 acres of land for a five-year period beginning November 1945. Nearly half of the area is located in Hokkaido; here a considerable portion of the area consists of peatbeds and marsh lands. Much of the area to be reclaimed in Honshu, Shikoku and Kyushu supports forests and low-growing brush. Apparently, many intermontane areas in Japan at elevations of 4,500 to 6,000 ft. are suitable for the growing of cereal crops, white potatoes, vegetables and pastures, but have been little used for crop production. Only about



The various coastal plains mentioned in this article are shown above



Terraced land near Sasebo, Nagasaki prefecture, Kyushu. A small stream has been dammed and the water used for irrigating rice

10% of the area to be reclaimed can be utilised as paddy rice land. The remainder of the area will be devoted to an upland type of agriculture. The most productive land to be put into cultivation (13%) is found on former military areas which occupy relatively smooth terrain.

Although plans for reclaiming an area equivalent to about 25% of the land now in cultivation is unquestionably highly optimistic, it is interesting that all of the land which might be cultivated is not being used for crop production purposes. An idea of the progress being made is given by the number of acres reclaimed (692,000 acres) as on April 1948. This is about 18% of the total planned to be reclaimed, accomplished in the first three years of the five-year plan. Nevertheless, with all the adversities with which the Japanese must contend, it is commendable that progress is being made toward putting food-producing land into cultivation.

More food through reclamation

Even though it is possible to increase the arable land area of Japan, the additional food crops harvested from this potential area are not expected to alleviate food shortages in that country altogether. Less food will be produced through reclamation of land to crops than estimated by the Japanese Government because (*a*) most of the really desirable land is already in use, (*b*) the majority of the reclaimable land left is inferior to the land now in cultivation, (*c*) the cost of reclamation on some land is prohibitive, (*d*) land has been included in the programme which is not suitable for reclamation, (*e*) a large part of the potential cultivated land is situated (Hokkaido) where both soil and climate are particularly unfavourable and an increase of acreage by double-cropping is not often possible, and (*f*) conversion of uncultivated land into fields in the mountainous areas is difficult and expensive.

How much additional food can be produced will depend on the amount of land that is actually reclaimed, the inherent fertility of the soil, the availability of commercial fertilisers and farm-produced manures, speed of settlement on these new areas by farmers, and other farm management practices attendant to the operation of farm units in Japan.

The effect of rice culture

In Japan more importance has always been placed on the growing of irrigated rice than on upland crops. Only a small amount of land exists now which can be reclaimed for paddy rice growing, while, on the other hand, quite extensive areas can be found on which upland crops may be cultivated.

In some areas, especially in the north, it was observed that some of the uplands adjacent to cultivated fields were in forest. There appeared to be no ecological reason for not putting these forested areas in cultivation. Reasons given in the Kwanto Plain area by the Japanese for retaining these areas in forest included (*a*) ownership desires to retain land in forest because it always had been in trees, (*b*) source for fuel and compost materials, (*c*) windbreaks for crops and wind erosion control, (*d*) maintenance of water table for cultivated land and (*e*) grazing areas for livestock. Investigation has shown that these reasons have basis in fact, but tradition appears to be the main reason for these relatively flat upland areas being retained in forest. In most cases it appears that trees growing on steep hill and mountain land could furnish the required timber products, while the level forested areas could be put under cultivation.

Probably no country takes better care of her rice lands than does Japan and the Japanese farmers are among the best rice growers in the world. They spare no effort in growing the crop; in many areas, in order to get more land for the growing of rice, especially in central and southern Japan, they have built elaborate terraces, often of stone requiring many hours to construct. But these terraces apparently were not put up only for the purpose of holding the soil in place. They were built also so that the land would be made level; water could then be directed on the land and irrigated for rice culture. It is true that dry land crops, such as wheat, barley and vegetables, are grown on this terraced land, but they are grown usually after the rice has been harvested. A rice and wheat or barley alternate rotation of crops is common in Japan.

The high priority given rice over that of other crops in Japan evidently has had its effect on upland cultural practices, but the meticulous care and arduous labour devoted to the rice paddy fields were not likewise spent on upland fields. In many areas it is not difficult to find upland fields with slopes of 30° or more in cultivation.

One reason why level areas are in forest (as in the Kwanto Plain) is because in many of these areas there is no source of water for irrigation readily available, nor is it practicable to bring irrigation water to them. Hills are terraced, for water can be collected at the top and then applied to the terraced paddy fields at lower levels. This relative non-concern for their uplands in comparison with the emphasis placed on their irrigated rice fields probably can be attributed to the centuries old rice-farming economy well known to the average Japanese farmer.

Summary

Good land use on the uplands has been relatively neglected, in comparison with land adapted to rice culture, resulting in land use practices in many areas which are conducive to decreased soil fertility and to soil erosion.

Increased attention is now being given to the reclamation of large areas of land for increased food production purposes. Most of the good land is now in cultivation and only poorer land is available for reclamation purposes. Although additional food will be produced on the reclaimed land, the estimates by the Japanese on the amount of land which can be reclaimed are undoubtedly optimistic.

From the *Journal of Soil and Water Conservation*, 1948, **3** (4)

Sesame

POTENTIALITIES OF AN ANCIENT OIL SEED CROP UNDER MODERN CONDITIONS

A. E. HAARER, F.L.S.

Sesame is one of the oldest of the cultivated annual oil seed crops. It has hitherto mainly been grown by peasant cultivators in the East and in Africa for domestic consumption and has received little attention in Western lands. It has, however, many favourable points, including a high percentage of oil which resembles but is in some respects superior to groundnut and sunflower oils, while the press cake is of high nutritional value. Its disadvantages have been the small size of the seed, the relatively low yields per acre, and its habit of 'shattering.' The evolution of new, high-yielding, non-shattering varieties and the application of mechanical methods of cultivating and harvesting the crop may be expected to increase its popularity.

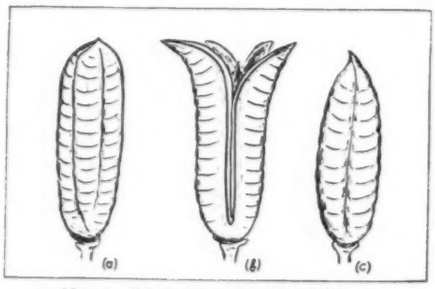
SIR GEORGE WATT wrote in his 'Dictionary of Economic Products of India'—'There seems no doubt that "til" was the first oil seed cultivated by man.' More recently, D. G. Langham in his article on the potentialities of sesame as a commercial crop states 'the western hemisphere has been slow in recognising its value.' Because the seed pod dehisces when it ripens, and the seed shatters, it has hitherto been difficult to cultivate and harvest sesame on a large scale, but research on improved harvesting methods in Venezuela, and the development of varieties which do not shatter, open the way for sesame to become one of the most important short-term oil-seed crops.

Characteristics

There are a number of other factors which make it desirable that more attention should be given to sesame.

Although the oil is classed equally with that from groundnuts and sunflower seed, sesame seed and press cake are of higher nutritive value, while sesame oil has special qualities which make it important in medicine and in crop protection. Furthermore, in comparison with an extraction percentage of 25% to 30% for sunflowers, and 30% to 45% for groundnuts, sesame seed gives the high oil extraction percentage of 45% to 55%.

The seed is known commercially as sesame, benniseed, til, gingelly and simsim; the botanical name of the plant is *Sesamum orientale* L. syn. *Sesamum indicum* L., a member of the family *Pedaliaceae*. No one knows when the plant was first cultivated, and the seed has been known as a food in India and China since 450 B.C. Some authorities endeavour to prove that the East Indian Archipelago was its original home, others consider that it may have come from Africa, but its cultivation is so widespread in tropical and equatorial regions that it is hardly possible to say where the plant was first domesticated. It is true that wild forms are found in many countries where the crop is now grown, but they may well have escaped from cultivation and deteriorated in form, so these cannot be regarded as factual proof of its origin.



Above: **Sesamum orientale** *L*
Below: **Capsule types**
(*a*), (*c*) **indehiscent mutant**
(*b*) **dehiscent normal variety**

Uses

World trade in sesame has declined during recent decades in favour of groundnuts, sunflowers and soya beans, which lend themselves better to mechanised methods of cultivation, but the chief reason why sesame has not appeared on world markets to any great extent is because so far it has largely been consumed in the countries of production. Small quantities of sesame oil are used for making margarine, shortenings and lard substitutes; it has long been used as a vehicle for drugs, and more recently as a dispersing agent for insecticides and other ingredients in aerosol bombs. As a synergist to pyrethrum it greatly increases the toxicity of that insecticide towards the common house fly.

Cultivated area

Before the 1939-45 war, the world acreage of sesame was roughly estimated as 11,500,000 acres, of which India accounted for 5,000,000, China 3,500,000 and Burma 1,500,000. The crop is also grown extensively in Manchuria, the Anglo-Egyptian Sudan, East and West Africa, Turkey, Greece, the Soviet Union and Mexico. In India and some other countries it is commonly grown mixed with other crops.

It seems that the total cultivated area did not decline very much during the war years; there was a substantial reduction in the acreage grown in India; Mexico and some South American countries, notably Venezuela, Columbia and Nicaragua, have increased their acreage.

Production

Annual world production of sesame before the war was more than 1,500,000 tons, of which the Asiatic countries produced 90% to 95%; China about 55%, and India, with a larger acreage, only 30% on account of mixed cultivation. During the war years, production in Asia may have been about 20% less, but this loss was made up to some extent by the increased cultivation in Mexico, the Sudan and Turkey, so that world production hardly fell more than 15%. The figures in the accompanying tables are extracted from the Commonwealth Economic Committee's report for 1948.

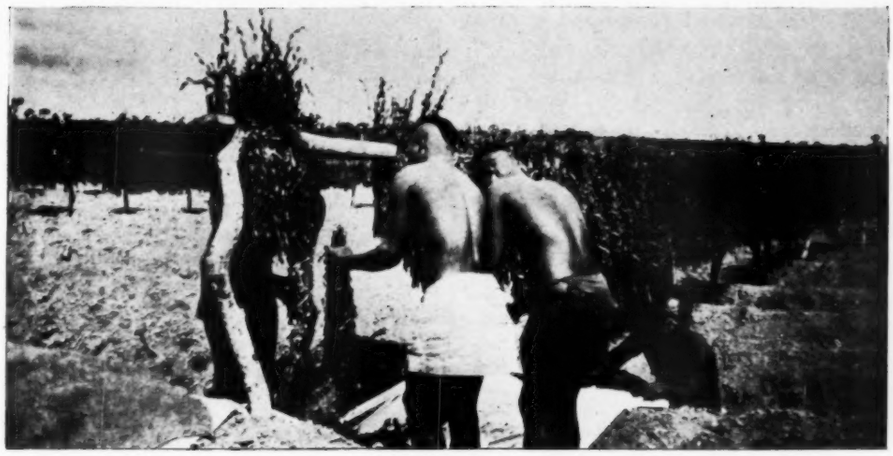
It is expected that when conditions in China and Burma settle down the production of sesame will recover, and there is also room for recovery in India and Pakistan. Quite a substantial increase may be obtained in South American countries and also, perhaps, in British African territories when the breeding of good yielding non-shattering varieties has progressed to the stage when seed supplies are available. This, it is estimated, will take about another two years.

International trade

The international trade in sesame has so far been small, since the average exports from the principal exporting countries has been only 140,000 tons. About 10% of the estimated domestic production in China provided about half the world total, and although the exports from Manchuria were sometimes considerable, the only other countries which exported more than 10,000 tons annually were India, the Anglo-Egyptian Sudan and Nigeria.

From 1941 onwards Commonwealth countries provided a larger proportion of the world totals, and exports were well maintained until 1944. Turkey increased her exports during the earlier war years, while Nicaragua made a considerable contribution towards the end, but the total exports in 1945 and 1946 averaged only 20,000 tons.

The U.S.A., Japan, the Netherlands and Italy took most of the exportable surplus from China before the war, Egypt took that from the Sudan, and Central Europe formed the market for most of the Nigerian exports. Supplies from China and Manchuria were diverted to Japan during the war, Nigerian exports were absorbed by the U.K., and Egypt took all of Sudan's surplus except in the years 1943 and 1944 when large quantities went to Palestine. The price payable for crude oil by the principal wholesalers and large trade consumers in Britain is the same as that which is paid for crude groundnut or sunflower oil.



Drying the seed capsules on railings

AREA UNDER SESAME IN THE PRINCIPAL PRODUCING COUNTRIES
(In thousands of acres)

	1937	1939	1941	1943	1945	1946
COMMONWEALTH:						
India*	4,450	4,031	4,145	4,306	3,936	3,795
Burma	1,371	1,450	—‡	1,040	1,120	1,262
Uganda	191	211	227	222	243	231
Palestine	64	47	54	42	27	46
Anglo-Egyptian Sudan	272	—‡	—‡	312	260	234
FOREIGN:						
China Free†	1,573	1,610	1,683	1,658	1,780	1,816
Mexico	169	151	260	421	440	450
Turkey	161	165	164	152	116	120
Soviet Union	120	156	—‡	—‡	—‡	—‡
Manchuria	112	143	—‡	—‡	130	130
Greece	88	120	—‡	—‡	—‡	80
Netherlands East Indies	38	37	—‡	—‡	—‡	—‡
Egypt	19	19	21	28	40	33
Iraq	12	17	32	59	47	54

*Main producing areas.
†Total for all China in 1946: 3,134,000 and 3,420,000 in 1937.
‡Not available.

PRODUCTION IN THE PRINCIPAL PRODUCING COUNTRIES
(In thousands of tons)

	1937	1939	1941	1943	1945	1946
COMMONWEALTH:						
India*	465	415	414	455	388	344
Burma	51	52	52	34	35	37
Nigeria†	13	10	13	10	7	4
Palestine	9	4	7	6	5	7
Tanganyika†	6	5	4	6	4	3
Uganda†	3	3	4	3	1	1
Anglo East Sudan	43	30	42	39	38	36
FOREIGN:						
China	962	970	600	550	630	640
Mexico	27	33	59	75	60	70
Turkey	24	34	34	32	15	25
Soviet Union	16	17	—‡	—‡	—‡	—‡
Greece	10	15	4	2	8	9
Manchuria	10	20	—‡	—‡	20	22
Egypt	6	6	7	8	11	9
Syria	4	5	3	5	4	5
Iraq	3	3	8	20	15	18

*Main producing areas. †Tonnages marketed. ‡Not available.

Composition of the seed

According to data compiled from various sources, the composition of whole sesame seeds is approximately as follows:

	%
Water	5.8
Protein (N x 5.3)	19.3
Fat as ether extract	51.1
Total ash	5.7
Crude fibre	3.2
Carbohydrate by difference including fibre	18.1

The calcium and phosphorus contents of the seed, expressed as the element in percentage of air-dry substance, are about 1.0% and 0.7% respectively, but the decorticated seed contains only about 3% of ash, with 0.08% of calcium and 0.68% phosphorus.

Dietetic value

The fact that the whole seed is extremely rich in calcium seems to have escaped the notice of dieticians until recently; it may partly explain why the whole seed, which is used so extensively in confectionery throughout the Orient, has such a high nutritional value. The seeds are rich in protein, fat and phosphorus; they have an agreeable taste, especially after roasting, when they can be used in many ways like nuts.

Malnutrition would probably be considerably worse among the poorer people of the Anglo-Egyptian Sudan and Egypt if it were not for the fact that sesame seed and its oil are regular articles of diet. A popular confection called 'tahniya' is made from sesame seed with sugar and flour, and most of the export of sesame to Egypt is used for this purpose. A 10% addition of sesame meal to flour has been used in Venezuela for the preparation of the national pancake-like bread known as 'arepa,' and since the bread is then more agreeable in taste, and decidedly more nutritious, it has met with general approval.

In Palestine the seed is pressed to produce a light edible oil, and the residue is used for mixing with flour and sugar to make 'khalawe,' a hard, white sweetmeat which is eaten with bread by the Arab population. Factories for producing khalawe abound in Palestine, and it has been a very important item of native diet. In South Europe a delicacy called 'halva' is made by mixing sesame with honey; in India the seeds are pounded with jaggery and are believed to purify the blood; and in China there are the ubiquitous small, flat cakes thickly coated with sesame seeds and tasting rather like Scotch shortbread. In many countries the seeds or the oil are used in cooking or confectionery. It is somewhat surprising that sesame has hitherto not been used extensively for food by northern European races.

Climatic and soil requirements

Sesame is an annual and many varieties are cultivated. It can be grown throughout the equatorial and tropical regions and in warmer temperate climates such as those of Manchuria, South Europe and South America, in fact, wherever its seasonal growth can be accomplished in summery weather without frost. The plant is not exacting in its soil requirements, though it thrives best in hot, dry areas such as the Sudan. Provided there is plenty of moisture beneath the surface for its vigorous tap root to exploit, the plant will thrive on moderate rainfall on sandy soils in an atmosphere of low humidity.

Stacking plants to encourage shedding of the leaves

Varieties

Varieties of sesame differ in their habit, while their growth is influenced to some extent by the richness of the soil and by the local rainfall and humidity. Some are dwarfish with a single stem, others grow tall and are much branched; in general the shorter single-stemmed varieties mature earlier.

Sesame in Burma

In Burma two main types are grown—an early and a late, but there is also an intermediate class. The early varieties have a life cycle of only 60 days and are usually grown on land which is afterwards cultivated for rice. The intermediate varieties have a life cycle of from 90 to 100 days, while the late ones are harvested after 100 to 120 days, and are usually grown mixed with other crops. In 1930 there were 886,496 acres of early and 343,353 acres of late varieties of sesame grown in Burma.

In Burma the crop is said to do best in the drier zones provided there is sufficient moisture and the soil is fertile; the seedlings appear in about four days. They make poor growth on stiff clays and a short stunted growth in very sandy soils if rain is infrequent.

In the Sudan

The sesame varieties grown in the Sudan are classified according to their growth, the amoun of branching and the seed characters, though the main character which distinguishes them is the period required for maturity. This ranges from 80 days with the quickest Fung type to the 180 days required by the slowest Equatoria strain. The early varieties are short in growth and often unbranched, while the later kinds produce a vigorous branched growth and consequent uneven ripening of the seed.

The general tendency of the plant throughout the world is to bear pods with four locules; however it often gives rise to twin pods with eight locules; plants doing this have sometimes been selected and given varietal names; these are not generally considered to have any special advantage over the more usual types and in Uganda the eight locule plants have been found to suffer from constant fasciation which reduces yields.

In East Africa

Sesame is a luxury crop in most of the native gardens of East Africa, but in the drier areas of south-east Tanganyika and in the north and east of Uganda it is more important, although it is still grown mainly for local consumption. Nearly 200,000 acres were planted to the crop in Uganda in the year 1936. A small amount of selection work has been carried out on two experiment stations in Uganda with the object of establishing pure lines of high-yielding, white-seeded strains. Of the five main types recognised, the tall, single-stemmed long-capsuled 'Nandigobe' variety appears to be the best.

Improvement of the crops

It is remarkable that so far little research has been attempted in Commonwealth countries to improve this valuable crop; in Uganda the fact that varieties imported from India and the Sudan, without exception, have proved inferior to those already established there goes to show the need for breeding and selection work to evolve types suited to varying conditions of climate and soil.

Stooking sesame in the Sudan

In Tanganyika, Allnutt has shown that natural crossing is rare and that the plant is nearly always self-fertile; this simplifies the breeding of pure strains. He also found that for some unexplained reason the intensity of pigmentation varies from capsule to capsule in plants producing coloured seed, but on the other hand individual plants produce either all pigmented or all white seed. If plants are selected while still in the sappy stage they will give an initial supply of 100% pure white seeds, and not many coloured seeded plants requiring rogueing will appear in the resultant crop. Throughout the world the white seed fetches an enhanced price, though it has been stated that the black seed produces a better oil.

Seeds of sesame are coloured white, yellow, red or black. Much of that grown in the Sudan is either white or red, and the paler coloured seeds usually predominate on account of the rough selection practised by growers.

Cultivation methods

The seed of sesame is generally sown broadcast in soil of a fine tilth where weed seeds are not numerous. A light scuffling is sufficient to bury the seed and only one weeding is attempted after the young seedlings have appeared. It was found in Uganda that yields could be improved by drilling in the seeds with rows spaced 9 to 12 in. apart. The difference in yield between the single-stemmed plants and those that are tall and branched is not very great because the larger plants require wider spacing. Native cultivators rarely thin their seedlings, though if this was done and optimum spacing adopted yields could be considerably improved.

Harvesting

Harvesting is done by hand when the lowest capsules on the stems begin to split open; at this time the upper capsules are turning yellow and the whole plant is losing colour. The cut stems are bunched together and usually strung inverted on racks so that the seeds fall on to mats placed beneath as the capsules ripen and open. Sometimes the stems are stooked upright in the fields until dry and then carried to a threshing floor where the seed is beaten out with sticks. There is often difficulty in separating the dirt and trash on account of the smallness of the sesame seeds.

Yields average only about 300 lb. per acre. A good yield is about 450 lb. per acre, though higher yields have been known. At the Instituto Nacional de Agricultura in Venezuela, geneticists have been working for some time on improving strains by selection, and their V-51 strain is reported to be very good. It is a single-stemmed plant which ripens more uniformly from base to tip, and when the capsules open the seeds are so loose that they can readily be shaken free. The Venezuelans have also isolated an indehiscent mutant, and are now endeavouring to transfer this gene to higher yielding varieties. Attention is also being given to the collection of wild types of sesame, breeding strains resistant to diseases and pests.*

Along with the breeding of better strains there has been research into better methods of harvesting. Binders are now in use for stooking the bundles of stems in the field like wheat; this is done five days before the capsules begin to open, and when the plants are dry they are either threshed mechanically or the seeds separated by inverting the bundles over sheets of canvas.

*Attempts to breed non-shattering varieties of sesame are also being made by workers of the Chemurgic Project of the University of Nebraska.—EDITOR.

Conclusion

Sesame as a crop has been largely neglected hitherto by the western hemisphere because it has been necessary to harvest by hand and because the seeds shatter so easily when ripe. With the advent of mechanical harvesting and of non-shattering varieties it seems not unlikely that its cultivation may increase considerably. It is more than probable that it has been grown in many unsuitable areas in the past, and this may have led to the opinions often expressed that the plant is very sensitive to environmental change. Research is undoubtably necessary to discover the optimum conditions for growth, to select and breed for higher yields and to obtain strains suitable for different soils and climates. If this is forthcoming developments will almost certainly follow.

BIBLIOGRAPHY

J. D. Tothill: 'Agriculture in the Sudan.'

J. D. Tothill: 'Agriculture in Uganda.'

D. G. Langham: 'Potentialities of Sesame as a Commercial Crop,' *Agriculture in the Americas*, Aug.-Sept. 1947.

Commonwealth Economic Committee: 'Vegetable Oils and Oil Seeds Summary Report for 1948.'

Extract from United States Year Book of Agriculture, 1934: *East Africa Journal of Agriculture*, Jan. 1936.

R. B. Allnutt: 'The Establishment and Maintenance of a Pure Supply of White Sesame Seed,' *East African Journal of Agriculture*, March 1936.

International Review of Agriculture of 1942, **33** (12).

A. McLean: 'Sesame in Burma,' Agricultural Survey No. 16 of 1902.

Andres Marquey: 'Edible Oils and Fats.' Revista de Ministerio del Formento Caracas, Jan. 1938.

Gerald C. Dudgeon: 'The Agricultural and Forest Products of British West Africa.'

H. F. MacMillan: 'Tropical Gardening and Planting.'

(Photos: pp. 219, 220 and 221 by permission of the Imperial Institute.)

New German Insecticide

The Chemische Fabrik E. Merck, Darmstadt, has developed a new insecticide called *Hortex* which is said to kill practically instantly on contact only.

It is a benzene hexachloride compound with, it is claimed, a 98 to 100% gamma isomer content. Because of its high purity it is said not to taint treated crops. It will be manufactured in powder or liquid form and be used initially for the extermination of the potato beetle.

Mounted Implements on the Farm

A. B. LEES

The introduction of mounted implements and hydraulic power lifts has brought about something of a revolution in mechanised farming by greatly improving the versatility of the modern tractor. There are several forms of power lift linkage, and the principles of operation of one of the best known of these—the Ferguson system—is described in this article.

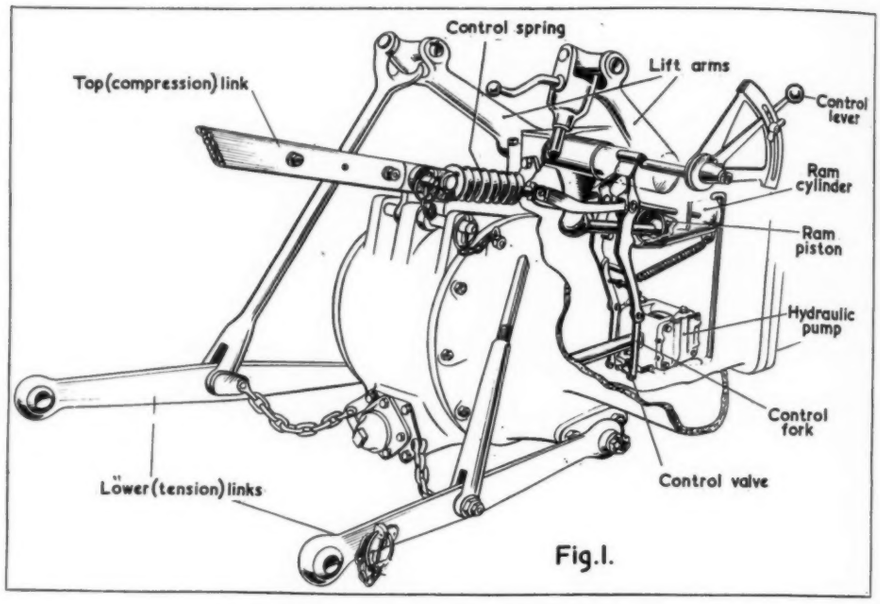
TODAY there are over 298,000 tractors of the three- and four-wheel type in the United Kingdom alone. If crawlers and two-wheel types are added there are nearly 350,000 machines. This rapid rise in farm mechanisation from 50,000 tractors at the beginning of the war is remarkable.

Two factors stand out as mainly responsible: first, the threefold increase in British farm wages; second, the increasing versatility of the modern tractor. In addition, the modern techniques of ley farming, weed and pest control, grass drying and so on can best be used with ample mobile power. Moreover, better performance and manoeuvrability permit these practices to be carried out in situations where it would have been impossible 20 years ago.

Manure spreading, trench cutting, excavation, mole draining, subsoiling, potato planting, transplanting, green crop loading, complete rowcrop cultivation, sawing of firewood and fencing, hedge cutting, laying of cables and water pipes and many other operations have come within the range of the medium-powered four-wheeled tractor during the past 10 years. It is this flexibility of use which has made such a dense tractor population possible.

Mounted implements

Coincident with the extended use of tractors has been the development of the mounted implement and the introduction of the hydraulic power lift, which must be considered one of the most important features of the modern all-purpose machine inasmuch as it enables tractor and implement to work as a single integral unit knit together by a power lift linkage and hydraulic control. There are several types of linkage, each of which possesses some special features; that known as the Ferguson system has been developed since the first world war and is usually considered as the forerunner of the modern phase in mounted implements.



General design of the Ferguson system

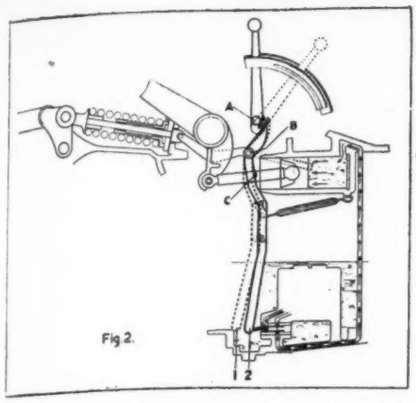
The Ferguson system

The system depends on natural physical laws and forces rather than on heavy inbuilt weight to give penetration; it ensures that the tractor automatically adjusts its pull to the job and that the implement maintains an even depth by automatic hydraulic control. The general design of the system, with the various parts named, is shown in Fig. 1. The linkage and depth control depend for their operation on the fact that all heavy draft ground-engaging implements are designed so that when they are drawn through the soil they tend to rotate forward above the points of attachment. A pyramid strut is built above the cross-shaft about which the implement tends to rotate, while a compression link is introduced between the top of this strut and a point above the rear axle of the tractor.

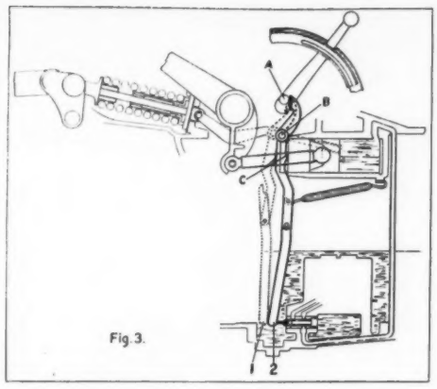
In working, a tractor tends to rear under the influence of the torque created by the back axle drive. Simultaneously, a force proportional to this rearing tendency is produced in the implement. The top link, which constitutes the third point of attachment, connects these two opposing forces and maintains the stability of both plough and tractor. Having achieved stability, weight is no longer required at the front end for safety. Consequently, the front of the tractor can be lightly built, resulting in easy steering, reduced rolling resistance and negligible compaction of the soil.

A second point of equal importance is the system of depth control which enables the implement to be carried on the tractor, not only for transport, but also when working in the ground. To achieve this, all depth control wheels are removed from the implement and the depth of work regulated by a hydraulic control mechanism.

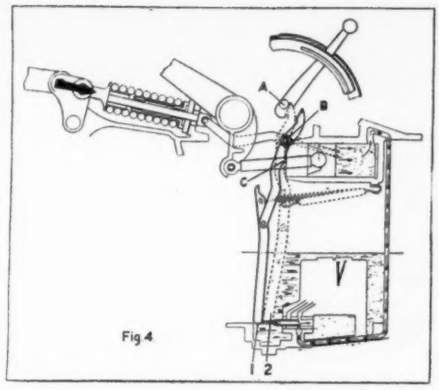
By measuring the oil pressure in the hydraulic system, while working with an implement in the ground, it has been found that with an implement such as a plough up to twice the weight of the implement can be added to the tractor rear axle. This comprises the weight of the plough, the weight of the soil actually



The workings of the hydraulic lift (*see text*)



The workings of the hydraulic depth control (*see text*)



The workings of the safety device (*see text*)

carried on the plough and the force which tends to draw the plough deeper into the ground. Weight added to the rear wheels gives traction when required for heavy work and also enables the tractor to perform light work economically.

This combination of front wheel stability and rear wheel traction has made it possible to design a cheap convenient versatile power unit for a range of implements. The implements themselves can be made simple and robust by the elimination of unnecessary parts such as depth control wheels, lifting gear, safety devices, etc.

Method of operation

The hydraulic control linkage functions in three distinct ways: (*a*) hydraulic lift, (*b*) hydraulic depth control, (*c*) safety device to protect tractor and implement from hidden obstructions.

Fig. 2 shows this in simplified form. When the control lever is moved forward, point A moves forward. The control fork pivots about point B and the control valve moves to the rear, releasing oil from the ram cylinder, while cutting off the supply to the pump. The implement then lowers itself under its own weight. When the lever is raised point A moves to the rear, the fork pivots about point B, the control valve moves forward, retaining oil in the ram cylinder, at the same time admitting oil to the hydraulic pump, thus raising the implement.

The hydraulic lift combined with the three-point linkage results in the following advantages: (*a*) manoeuvrability, (*b*) safety from rearing when pulling up hill or when hitting an underground obstruction, (*c*) a light front end contributes to manoeuvrability and materially reduces 'rolling resistance' on soft ground, (*d*) easy transport of implements.

Equally important is depth control. To understand this reference should be made to Fig. 3. The control lever is lowered, moving point A forward and withdrawing control valve to the 'lower' position (2). As the tractor is moving forward and soil resistance makes the implement rotate forward about its two lower points of attachment, the top link compresses the control spring, moving point B forward and returning the control valve to the neutral position. Deeper implement penetration is checked and depth control established.

If the lever is pushed further down, greater compression of the control spring is required and the implement settles at a greater depth.

Advantages

Hydraulic depth control has the following advantages: (*a*) implements require no depth control wheels, (*b*) having no wheels the weight of implement is carried on tractor while working and its weight is added to the back axle, thereby increasing the traction power of the wheels with the consequent advantage that the tractor can be built light and yet do heavy work when required; a light tractor does not pack the soil, is economical for light work and is easy to handle.

When an implement encounters a more or less immovable obstacle below the ground the momentum of the tractor and, even more important, the flywheel of the engine exert a pull many times greater than the normal tractor effort. This pull is, however, only effective while the tractor and engine are actually being slowed down; it is known as a 'shock loading' and is responsible for most of the damage to implements encountering rocks and roots. To overcome this, when an implement encounters an obstruction the shock loading almost collapses, the control spring (Fig. 4) moves point A about an inch forward and brings point C into contact with the ram cylinder. This withdraws the control valve to the 'lower' position and the implement is lowered. As the tractor gains its rear wheel grip by carrying the implement, it follows that when the implement is lowered the tractor loses its grip and the rear wheels are left free to spin. The powerful thrust which collapses the control spring also throws the weight of the tractor forward on to the front wheels, still further reducing the rear axle load. These two effects operate momentarily while the tractor and engine are being slowed and harmlessly dissipate the dangerous forces created by sudden stopping.

This simple device not only prevents breakages, but makes it possible to plough and cultivate areas which are unused because of the risk of damage from rocks or roots, etc. The other and greater danger of a tractor rearing back on to the driver is, of course, eliminated by the three-point method of attachment.

Conclusion

To conclude, the hydraulically-controlled mounted implement has brought new standards of efficiency, safety and manoeuvrability to farm mechanisation and it has been largely responsible for making British agriculture the most highly mechanised in the world.

Australian Agricultural Research

A new scientific periodical, *The Australian Journal of Agricultural Research*, has been established by the Commonwealth Scientific and Industrial Research Organisation in collaboration with the Australian Institute of Agricultural Science and the Australian Veterinary Association as a medium for the publication of research papers in the broad field of scientific research on soils, plants and domestic animals. The journal will, it is noted, cover physical, chemical and biological aspects of this field.

CORRESPONDENCE

The Millets

To the Editor,

Sir,

I have been looking for authoritative articles on the millets, hence I read the article by Dr. Mann in your issue for March of World Crops with interest.

Some of the statements are astonishing: 'They form the principal food grains of perhaps one-quarter of the world's population'!

The *Statesman's Year Book* gives the world's production of the principal cereals in bushels; the total works out at about 621 million tons of 2,240 lb. for wheat, rice, maize, oats, barley and rye. There is no mention of millets.

If millets supply one-quarter of the world's population, then the 621 million tons of the other cereals must supply the other three-quarters only, which works out at about 194 million tons for a quarter of the population. Does Dr. Mann really believe that millets are grown to that extent?

Millets may be grown easily enough, but the harvesting is another matter. Small birds are common enough in rice fields at the time of harvest, but where there are millet crops they collect in their thousands, especially munias. Shattering is another trouble. I know of a whole harvest lost because one very dry hot day with high wind caused shattering of the Eleusine crop before it could be harvested.

I notice that Dr. Mann states 'in some Asiatic countries is so consumed as a cattle food.' That is probably correct. But where is it all grown?

It is very difficult to estimate the amount of any crop which is grown as a famine crop, because, when the harvest of the other cereals is good, the millets grown as an insurance against failure of the rains is to a great extent neglected. The same applies to some pulses, such as the lathyrus pea, which is sown with the barley, but only largely reaped in famine years. I am referring to India. I am not very familiar with African or Chinese conditions.

Yours faithfully,

Lucius Nicholls,

Harford, Shurdington,
Nr. Cheltenham.

Dr. Mann replies:

I have read Dr. Nicholls's letter with interest and have checked up on my statement that millets, including sorghum, probably form the main food of perhaps a quarter of the world's population. Naturally, any such statement is a guess, but after verifying my references, I do not think that it is very wide of the mark. I am not surprised that the *Statesman's Year Book* makes no mention of millets. These are, as I have stated in my article, not a large feature of international commerce and are little used in the West except for animal feeding and would not be likely to appear in a book prepared for Western and commercial use.

May I give some data with regard to India, which country I know well and where I worked for many years in an area where sorghum and spiked millet are the principal food crops of the people, not only in drought years, but also under normal conditions? In British India as a whole (see *Statistical Abstract*, 1940-41) the millets occupied nearly 39 million acres, far more than wheat or indeed any other crop or group of crops except rice. These figures do not include the states where millets are grown extensively, and in India as a whole there would certainly be over 44 million acres under the various millet crops. In British India it was estimated that the two principal millets yielded in 1940-41 7 million tons of grain.

I have not the personal experience of China and the adjoining countries that I have of India, but so far as these are concerned a recent authority (Ball, *The Kaoliangs*, Washington), states that sorghum is found all over the west and north, and that in Manchuria these crops become highly important staples on the farm. They are found in Korea largely and to a lesser extent in Japan. I do not think it is exaggerating to say that in these Far Eastern countries from 100 to 150 million people are mainly dependent on sorghum and other millets for their chief food.

In Central Asia and on to the North Caucasus millets are a great standby, especially of the semi-nomadic peoples. In the U.S.S.R. a recent estimate gave millets as forming 7.7% of the grain production. If we allow only half of this as being used for human food, it means that it is the main food of perhaps 8 million people. In the Middle East, where my work has lain in recent years, millets are less used, but even there, in Turkey, the area was in 1946 over 60,000 hectares and the estimated yield was over 60,000 tons. As one goes south from there in the Middle East millets become more and more relatively important, and in Arabia they form almost the only grain food available.

In Africa, south of Egypt and the north coast, and to the north of the Rhodesias, the millets form the main food of the people, though, I confess, there has been a tendency for maize to extend at the expense of sorghum. It would not be far from the truth, however, to say that about one-third of the population of Africa live on sorghum and other millets. Even in Europe there is a limited area of consumption in the Balkan countries and a declining area both in Germany and France.

All these, added together, would, I think, justify my statement. It is, of course, impossible to be exact in such matters, but the very extensive use of millets as the main food of a large portion of the human race, even in normal years, is not in doubt.

Harold H. Mann,

Woburn Experimental Station,
Husborne Crawley,
Bletchley.

French African Cocoa Markets

The French African Cocoa Purchasing Agency has been dissolved and cocoa can now be bought and sold freely. Quotations are fixed each week on a centralised market where shippers, brokers and consumers meet.

Before the war France exported 90,000 tons of cocoa produced by her overseas territories of Togo, the Ivory Coast and the Cameroons, and experts in Paris believe that this rate could be considerably increased. French African cocoas have already regained favour in British and Dutch markets.

New Agricultural College

A new agricultural college was recently opened at Gwebi in Mashonland, S. Rhodesia. The college had to be built at a cost within the limit of available funds and it is now hoped to expand it by next year.

The principal of the college is Dr. W. L. Fielding.

A genuine test for tractor and implement. A Fordson Major and 3-furrow plough bursting up pastures which have never before been considered accessible to tractors and implements

The mechanical muck-spreader takes much of the back-breaking out of this seasonable job

New Forage Harvester

With the ever-increasing difficulty of obtaining feeding stuffs, and particularly those with a high protein content, farmers are realising that to meet their demands they must produce their own. New equipment for cutting and loading green crops into trailers has been designed by Fisher Humphries and Co. to facilitate both silage making and grass drying.

Their new forage harvester is capable of both cutting or picking up the crop from the field and loading it into a trailer, from whence it is conveyed to either the silo or the drier. The harvester can be fitted with either the conventional type cutter-bar or with a pick-up reel. With the cutter-bar fitted the harvester will cut standing green crops, such as grass lucerne, etc., chop and load them into a trailer. The chopper can be bypassed if so desired and the crop loaded direct. If required, the machine is capable of cutting the crop and leaving it in windrows on the ground, where, after wilting, it can be picked up by the reel, chopped and loaded into a trailer.

In many areas of the United Kingdom it is now common practice to plough in all straw and stubble left by a combine harvester, and long stubble has always presented a problem to the farmer, as he finds it difficult to bury satisfactorily. To simplify this problem the harvester can be used for cutting the stubble at ground level, chopping and depositing it back on the land, in which state it can be more readily ploughed in.

The harvester can be towed and the mechanism driven by any medium-sized tractor fitted with a power take-off which operates the entire mechanism of the machine. From either the cutter-bar or the pick-up reel the crop is fed on to a conveyor belt which delivers it on to a cylindrical feeder roll, where it is pressed and fed across a shear plate to the chopping drum. Chopping is carried out by four spiral blades against a tool-steel shear blade this shear blade being adjustable for wear. The chopped crop is thence delivered by centrifugal force and air blast to a slat type canvas elevator and is loaded into a trailer via a deflector hood.

The harvester can also be used as a stationary chopper and elevator for fodder. For sharpening the chopping drum a built-in blade sharpener is provided. For use with tall crops the machine is fitted with an adjustable four-bat reel.

A prototype of the machine will be on show at this year's Royal Agricultural Show, which is being held at Oxford from July 4 to 7.

Australian Tractor Plant's Output

The International Harvester Co.'s new tractor plant at Geelong is now turning out complete tractors at the rate of 300 every month. The tractors, which are made in two models—the McCormick International W-6 and the Farmall M—were previously imported from America.

Dealers from all parts of Australia visited the new factory recently and watched 30 tons of molten metal become 10 complete tractors within seven hours.

Robot Screen for Compost-Making

The Indian Agricultural Research Institute has devised a robot screen to make compost from town refuse at cheap prices. An improved version of a hand-operated screen devised by the Institute would enable production of 1 ton of compost at the cost of Rs. 1/8 (2s.). The screen is worked in conjunction with a tractor-operated loader discharging about 10 tons of material every hour.

French Equipment Scheme

M. Paul Ihuel, French Secretary of State for Agriculture, told the National Assembly that a farm equipment scheme costing 50,000,000 francs would be put into operation this year. This would represent 9% of the state modernisation and equipment budget.

Farmers claim that French agriculture, if sufficiently modernised and equipped, could produce enough to feed 70,000,000 people. The Minister of Agriculture has now promised to cut prices of fuel used in farming, to reduce taxes on fertilisers and to provide stock-breeders with cheaper animal feeding-stuffs. He has also said that farm prices will be guaranteed and new outlets for farm products sought, notably in Germany and Britain.

NEW BOOKS

The Plums of England

By H. V. Taylor, C.B.E. Pp. viii and 151. Illustrated. Crosby Lockwood, London, 1949, 30s.

The publishers are to be congratulated on adding a third book to the series on the fruits of this country and on obtaining the services of so eminent a horticulturist as Dr. Taylor to write it. As a commercial fruit the plum is at the present time rather under a cloud, probably because the public is no longer interested in plum jam and stewed plums, for which purposes only the vast majority of our commercial plums are suitable.

Like its predecessors on the apples and the cherries, the greatest value of this book is in the varietal descriptions and the 32 coloured plates which are, with few exceptions, quite admirable. Indeed, when one reads the glowing descriptions of the flavour and appearance of many of the 114 varieties detailed in Part II, one wonders why only 5% of the six million plum trees shown by the 1944 Fruit Census were of the choicest dessert varieties, the demand for which is evident from the ready sale for imported dessert plums. Dr. Taylor gives some of the answers, but he does not mention the liability of many of the best to split as they ripen so that the grower must market them unripe and flavourless if he is not to waste a large part of his crop. Information on this point would increase the value to prospective growers of gages.

In former days, as the late Dr. H. E. Durham said, the recognition of varieties was ' largely a matter of reference to those of good vision, trained eyes and good memory.' Foremost of those to whom he referred was the late E. A. Bunyard who, however, admitted at the same Royal Horticultural Society Conference that ' the systematic pomologist is haunted when determining a variety by the thought of the thousands of varieties he has not seen compared with the hundreds he may know.' Various attempts at systems of classification of fruits have been attempted, but none yet has proved wholly satisfactory. For the present, fully realising the difficulties, Dr. Taylor classifies over 100 varieties on the colour and shape of their fruit, thereby enabling the would-be identifier to narrow the name down to one of three or four. But even with this simple method there is room for much argument. Thus the writer cannot agree that Denniston's Superb is a round plum and the illustration of this variety (Plate XI) supports his view. Nevertheless, the descriptions in this book will be a real help to all plum growers, amateurs and professionals alike.

Part I of the book contains 11 chapters dealing with the botanical origins, culture, pollination, distribution, diseases and pests, domestic uses, etc., of the plum and concludes with short lists of varieties suitable for gardens and commerce. (Incidentally, one among the latter, Ontario, is not described in Part II.) But we are still left wondering which varieties Dr. Taylor would grow himself in *his* garden—surely not Czar !

Much in this part of the book is still controversial and seems in places unduly influenced by wartime considerations. Further, there are a number of small errors which no doubt will be put right in subsequent editions.

Pruning is hardly mentioned and although, in connection with Brown Rot control, the spring and summer months are suggested as convenient times for pruning, the need to avoid making large pruning wounds in the winter months when the trees are most readily infected with Silver Leaf is not emphasised.

It is hoped that in future editions Dr. Taylor will amplify this part of the book to include some aspects of plum growing not touched on at present. In the meantime, all fruit lovers will thank him for a valuable addition to their horticultural bookshelves.

T. N. HOBLYN.

Salad Crops Under Glass

Bulletin No. 143 of the Ministry of Agriculture and Fisheries. Pp. 23. Stationery Office, 1s.

This bulletin completes the trilogy* dealing with salad crop production, for which, as the foreword tells us, ' the demand is not only increasing but is maintained throughout the year.' The particular crops covered in this bulletin are lettuce, mustard, cress, radish, mint and cucumber. Each section deals with aspects of production from cleaning up after the previous crop to packeting and marketing the finished product. There is, of course, much that is not included, particularly in the field of pest and disease control, but for a 23 page bulletin there is a surprising amount of information for the grower who contemplates producing salad crops. It is illustrated with 13 photographs. R.G.P.

*The two previous bulletins are No. 55, ' Outdoor Salad Crops ' and No. 65, ' Crop Production in Frames and Cloches.'

The Clove Tree

By G. E. Tidbury. Pp. 212. Illustrated. Crosby Lockwood, London, 1949, 18s.

Information on cloves is scattered through agricultural literature, and there has for long been scope for a comprehensive book on the crop. From its title one hoped that Mr. Tidbury had provided this, but in fact his recent publication is not as comprehensive as its title would lead one to expect, for it deals almost exclusively with the clove industry in the Zanzibar Protectorate and practically ignores the not inconsiderable production of Madagascar, and also the Malayan Archipelago where the tree is indigenous. It is true that Zanzibar produces three-quarters of the world supply of this spice but, even so, much may surely be learned from a study of the tree in other countries.

Within the self-imposed geographical limitation which the author has set himself, he has succeeded in providing a concise and authoritative account of the industry. A short chapter on the history, geographical distribution and trade is followed by chapters in which the plant is described and the plantation methods from seed to finished product set forth, together with chapters on diseases and pests, costs of production, methods of valuation of plantations, legislation affecting the industry and the products and uses of cloves. Excellent illustrations enhance the value of the volume and greatly assist understanding of the text.

Mr. Tidbury writes with authority and clearness on cultural methods and the plantation system. It appears that improvements in methods of picking are desirable and that the reputation of Zanzibar cloves would be enhanced if kiln drying replaced sun drying. The chapters concerned with costs and the economics of the industry record information which probably cannot be obtained from any country other than Zanzibar.

The urgent need of further research is unconsciously revealed by the author. Selection and breeding appear to have been neglected, knowledge of the most suitable soil and the manurial requirements of the crop are incomplete, while the recommendations for manuring appear to be based on slender evidence. In view of the large areas now being replanted on land that has borne cloves for over a century, more definite knowledge is very desirable. The incidence of Sudden Death disease is, rightly, given prominence, and the numerous theories advanced to account for it are discussed. The author inclines to

the view that Sudden Death is attributable to one of several alternative causes.

Mr. Tidbury holds a favourable view of the future of the industry in Zanzibar. He believes that under good management the ideal unit is a property of from 500 to 3,000 trees, depending on the nationality of the owner, an area that should permit him to live in comfort and encourage him to extend his planting to other crops to his own benefit and that of the Protectorate.

D. H. GRIST.

The Pest Control Farmers' Handbook

Compiled by W. E. Ripper, A. L. Abel, R. M. Greenslade, S. G. Jary, F. R. Petherbridge and R. W. Shorrock. Pp. 100. Pest Control Limited, 9th edition, 1950.

The 'Pest Control Handbook,' in spite of its size, contains plenty of information on the progress in developing new methods.

It covers the treatment of most of the common arable crops, grassland and orchards for their various weeds, pests or diseases and is profusely illustrated, including 16 colour reproductions of the most common weeds. This year there is also included an account of the Pest Control Organisation's first ten years and the work that they are carrying out abroad.

R.G.P.

Spring Seeds

This year's spring catalogue of the Pure Seed Co. includes a pictorial tour of the company's seed station at Linton, Cambridgeshire, with photographs of the seed cleaning and dressing plant, giving a good idea of the processes through which the seed goes before it is sacked. The spring barleys listed are Earl, Spratt-Archer 37/6/3, Plumage-Archer 1935 and Camton. The last-named is a stiff-strawed variety bred to produce high yields of grain of good feeding quality. The spring oats include the well-known varieties Onward, Star, Victory and Eagle, with two recent additions to the list, Sun II and Minor, both recommended for highly fertile soils because of their excellent resistance to lodging.

The recommended spring wheat is Atle, claimed to be equal to any other spring variety grown in the U.K. There are photographs of all the grains with descriptions of their performance and data on their origins.

Agriculture in Fiji

A native village of thatched huts set amid coconut palms, Fiji

FIJI, like most Colonial territories, is primarily dependent on agriculture for its prosperity, and 1948 reports for trade and agriculture, which have recently reached this country, reveal that the value of exports (including re-exports) rose during 1948 by £1,646,710 to the record total of £7,789,512. This substantial increase was principally due to increased exports of sugar and copra products, and to the higher prices paid for copra products.

Main export crops

Fiji's exports contribute to the hard currency resources of the sterling area. In the year under review, Canada and the U.S.A. formed the largest single market for the Colony's produce, taking between them over 37%, by value, of total exports. The United Kingdom took 31% of Fiji's exports and New Zealand some 26%. The following table shows Fiji's principal agricultural exports in 1948:

Product	*Quantity*	*Value*	*Percentage of total exports*
Sugar	149,494 tons	£4,265,406	55
Copra products:			
Copra	21,352 ,,	£1,807,485	23
Coconut oil	9,053 ,,		
Coconut meal	4,391 ,,		
Bananas	289,371 bunches	£94,996	1

NOTE.—In 1948 gold figures were: 105,712 oz. exported, valued at £1,011,225, amounting to 13% of total exports.

Sugar is Fiji's main cash crop and, in 1948, the amount produced was 136,500 tons, the highest figure reached for some years. At the end of 1947 there was a considerable quantity of sugar awaiting shipment, and as a result about 13,000 more tons were exported than were actually produced in 1948. Of the amount produced 8,000 tons were consumed locally and the balance was exported as raw sugar by arrangement with the United Kingdom Ministry of Food under a long-term contract. Of the total tonnage exported over 40% was sent to Canada and earned about £1,900,000 in hard currency.

During 1948 there were about 46,000 acres under cane in Fiji, or about one-eighth of the total land under agriculture. Sugar cane production is mainly in the hands of Indian farmers, but increasing interest in this crop is being displayed by Fijians. The Colonial Sugar Refining Company, the only sugar company operating in the Colony, is concerned with raw sugar production and owns five mills; cane is purchased from tenants operating on land under the control of the Company or from contractors, who are estimated to produce 60% of the cane used. Refining is carried on outside the Colony.

Copra products reached a record figure during 1948 of nearly 35,000 tons, obtained from 130,000 acres of plantations, or

about one-third of Fiji's cultivated land.

The banana-growing industry is almost entirely in the hands of the Fijians, who grow the crop on their communal lands. Almost all the fruit is shipped to New Zealand but, during the year, an attempt was made to send some supplies to Canada; it is hoped that the market may soon be greatly expanded, with more adequate shipping facilities.

Pineapples are the only other export crop of any importance—about 550 tons, valued at over £34,000, were shipped during 1948, the greater part being canned pineapples. The fruit was marketed in New Zealand, and some shipments were also sent to Canada to open up new markets, and earned there about £10,000. In addition, about 104,000 lb. of pineapple juice, valued at £3,600, were exported. Two companies operate canning factories in Fiji; the Colonial Sugar Refining Company and the Colonial Pineapple Packing Company.

Local food crops

For some years it has been the main concern of the Department of Agriculture in Fiji to increase production of foodstuffs for local consumption, both by encouraging improved husbandry and extending the areas planted. Together with the traditional root crops of the Fijians, such as dalo, yam and cassava, rice is the most important foodcrop; during 1948 the area under rice increased from some 25,000 acres in 1947 to 34,000 acres, yielding approximately 17,000 tons of rice. Although mainly an Indian crop it was grown increasingly by Fijians, who have recently come to appreciate its value as a food and cash crop.

Considerable quantities of ghee (clarified butter) are produced by peasant farmers for domestic consumption, though not sufficient yet to meet local requirements. During the year the butter-fat production by the two factories in Fiji was about 456,000 lb. (including nearly 7,000 lb. of ghee, exclusive of production by peasant farmers); about 556,000 lb. of butter were also marketed.

Forestry

Forestry in the Colony is in its infancy, since the Department was not formed until 1939, and work was retarded owing to the war. However, in March 1948 a motion was passed in the Legislative Council strongly advocating more active utilisation of timber resources to meet local needs and conserve dollars, and urging that a long-range policy of re-afforestation be initiated as soon as possible. As a result, a committee was appointed to consider proposals for a forest policy and a plan of action. Nursery beds were constructed during the year and a number of plantations were extended. Experiments have since been made by the Public Works Department in using for building construction mahogany logs supplied from a plantation established seven years ago by the Forestry Department.

A standard 2-ton cane truck on a portable line, loaded with cut canes. The Colonial Sugar Refining Co. keeps in use 6,400 of these trucks

New agricultural developments

One of the main developments of 1948 was the promising start given to the principal agricultural experimental station at Koronivia, near Suva. The station comprises over 400 acres of typical farm land and, by the end of the year, a large area had been cleared and drained, fences erected and roads built. A good deal of the land has been ploughed and planted with varieties of fodder grasses, rice and citrus fruits—some for pest and disease control trials, and some to provide distribution of planting material to farmers.

In addition, important work was carried out during the year by the Agricultural Department in Fiji in extensive soil conservation projects, weed control campaigns and investigation into insect pests of rice. Assistance was also given by the Department to Western Pacific High Commission Territories, and visits by technical staff were made to the Solomon Islands and Tonga. Accompanied by an expert from the Cambridge School of Agriculture, the Fiji Entomologist made an investigation into the premature nutfalls of coconuts in the Solomon Islands, as a result of which control methods were proposed and further research mapped out. In Tonga, the Deputy Director of Agriculture made a survey of agricultural industries and presented a report to the Tongan Government embodying suggestions for the improvement of local agriculture.

New ventures in 1948 which will help to broaden Fiji's economy were the expansion of the candlenut-oil extraction industry (the oil is used in the manufacture of paint), the erection of a factory for tapioca starch production, and an experiment in tobacco curing; a trial crop was harvested and cured and is now maturing.

Large Farm Development in S. Rhodesia

The intensive development of a large agricultural estate, is now being demonstrated at 'Frogmore,' the 12,000 acres of which lie beyond Msonneddi, Southern Rhodesia. The year's work has been impressive, with the centre-piece a large dam; in its present form it holds nearly 500,000,000 gal. and has been built in about seven months. After a 25 in. total fall of rain the dam filled, being 40 ft. deep near the wall. To carry the water to the lands to be irrigated, main furrows 12 miles in length have been constructed. It is planned to irrigate 1,100 acres, rising to 1,450 acres, and then to 1,850 acres when the dam's capacity is doubled by raising the wall 9 ft. The crops grown will be potatoes, lucerne (for pedigree stock), barley, citrus, apples and vegetables.

For many years the farm was run on customary lines, but at the beginning of 1949 a company was formed with considerable capital, and a programme for more intensive development and considerable irrigation was put into operation.

WORLD CROP REPORTS

Italian fruit and vegetable exports up

Exports of fruit and vegetables from Italy last year, with the exception of potatoes, reached pre-war levels and showed an increase over the previous year (1948).

The figures are considered very satisfactory, particularly because growers were concerned about the results of devaluation in the sterling area and, consequently, a possible falling off in their export trade. That this has not been the case so far may be seen from the figures in the following table.

ITALIAN EXPORTS OF VEGETABLES AND FRUIT 1938, 1948 AND 1949 (in metric tons)

	1938	1948	1949
Potatoes	143,070	104,775	63,828
Fresh vegetables ..	193,192	173,512	198,859
Citrus fruit ..	355,660	280,066	355,551
Fresh fruit ..	212,197	235,367	334,539
Dried fruit ..	63,152	49,262	63,470
Chestnuts ..	26,340	21,324	24,907
Peeled tomatoes ..	53,095	28,317	30,151
Tomato paste ..	29,855	19,291	20,654

Colombia's coffee exports lower

Colombia exported about 3% less coffee in 1949 than in the previous year, according to the American Embassy in Bogota. Coffee exports declined from 5,588,000 bags in 1948 to 5,410,000 bags in 1949. The decrease is attributed to inadequate transport facilities during the months of November and December 1949. Colombia's coffee exports averaged 3,980,000 bags annually in the pre-war (1935-39) period.

The percentage of Colombia's coffee exports to the United States to Colombia's total coffee exports fell off from 93% in 1948 to 90% in 1949. Europe's share of Colombia's coffee shipments increased from 3% in 1948 to 6% in 1949. Next to the United States, Canada was the leading destination for Colombia's coffee exports in 1949, taking about 200,000 bags. Most of Colombia's coffee shipments to Europe went to Finland, Belgium, Germany, Sweden and Switzerland.

Mexico forecasts record agricultural exports

Increasing export markets for Mexican agricultural products have been responsible for the country's expanding agricultural industry and Ministry of Agriculture officials predict that Mexico will export this year more agricultural products than ever before, especially cotton and sugar.

Cotton experts believe that the country's 1950 cotton crop may be above the 800,000 bale mark. Mexico's domestic cotton needs are placed at nearly 400,000 bales this year, leaving at least an equal amount available for export.

If Mexico should produce 750,000 tons of **refined sugar** this year, which represents an increase of about 50,000 tons over last year, it can export at least 200,000 to 250,000 tons.

Wheat production is expected to be between 700,000 and 750,000 tons, compared with 550,000 tons produced last year. The country is still expected to need wheat from abroad, but the Government hopes to be able to suspend wheat imports by 1952. A minimum price of 500 pesos per ton has been fixed as an added incentive to new wheat producers.

Mexico's other important grain—**maize**—may be produced in record quantities. Government experts believe that the country may produce 3,250,000 tons, compared with 3,150,000 last year, which gave an exportable surplus of 152,000 tons.

Coffee growers are expected to produce more in view of the favourable export market they had last year because of the failure of the Brazilian crop. No estimates have been prepared by the Ministry of Agriculture yet, but trade circles expect that the crop will be slightly higher than last year, when production was about 900,000 bags of 132 lb. each.

The country's 1950 **bean** crop may be as high as 220,000 tons, according to current estimates, compared with 209,000 tons produced last year. Beans, together with maize and rice, form the basis of Mexico's popular diet.

Rice production this year is not expected to be far above last year's crop of 180,000 tons.

Mexico's Government banks are setting aside several hundred million pesos this year to be invested in further agricultural expansion projects, such as increasing irrigation facilities.

Pakistan's rice area larger

The second estimate of Pakistan's 1949-50 rice acreage is 20,684,000 acres, an increase of 47,000 acres over the December forecast, according to the Directorate of Statistics. Compared with the previous year's forecast of 20,710,000 acres, there appears to be a nominal decrease of 0.1% in 1949-50.

The area under autumn rice in East Bengal, the main producing area, is stated as having decreased by 5%, whereas other provinces and states have registered increases in the acreages. The condition of the crop was reported to be normal.

Biggest ever sisal crop in Tanganyika

The Tanganyika Sisal Growers' Association announced recently that the quantity produced in the territory during the past year was the largest ever recorded.

The crop for 1949 is expected to fall little short of £12 million in value.

Total production was 123,296 tons, showing an increase of 2,674 tons on the 1948 figure. Tanga Province made the largest contribution to this total and registered an increase of 4,321 tons.

An export tax of 5% on the f.o.b. value of each grade of sisal has been imposed by the Tanganyika Government, unless that value is less than £75 per ton, with effect from the beginning of this year. A committee has been set up to enquire into the ability of the industry to pay this tax without hindering its future development and expansion.

U.K. tobacco imports rise

Imports of unmanufactured tobacco into the United Kingdom in 1949 were 7% above the 1948 level. Leaf imports totalled 301.1 million lb. in 1949, compared with 280.8 million in 1948 and 295.6 million in 1947. Flue-cured leaf accounted for 82% of total imports in 1949. This compares with 88% in 1948 and 87% in 1947.

UNITED KINGDOM IMPORTS OF UNMANUFACTURED TOBACCO, 1949, WITH COMPARISONS

Country of origin	1947 1,000 lb.	1948 1,000 lb.	1949 1,000 lb.
S. Rhodesia	22,969	43,851	46,471
Nyasaland ..	11,908	14,073	17,769
India ..	22,942	22,815	38,332
Canada ..	22,224	12,686	12,980
Other British countries ..	2,056	3,878	3,481
U.S.A. ..	201,235	172,383	154,079
Turkey ..	*	10,155	19,993
Other foreign countries ..	12,286	934	8,027
Total ..	295,620	280,775	301,132

*Included in 'Other foreign countries.'

Tunisian olive oil production

Tunisian olive oil production last year amounted to nearly 100,000 tons, out of which 25,000 tons have already been exported, including 14,000 tons to France. The number of olive trees totalled 22 millions at the end of 1949, against 8 million in 1920.

It is believed that the next crop will be excellent owing to recent heavy rains.

Crop production raised in Brazil . . .

Brazil's agricultural production in 1949 constituted a record for the last five years. According to statements issued by the Production Statistics Service for the period 1945-49, home production totalled 62,858,593 tons last year. Compared with 1948, the increase was 858,539 tons.

Among the products to which these figures refer were the following:

Pineapples	81,924,000	
Alfafa	182,198	tons
Garlic	17,184	,,
Peanuts	139,531	,,
Oats	10,765	,,
Bananas	147,921,000	bunches
Sweet potatoes	968,090	tons
Potatoes	727,879	,,
Cottonseed	791,311	,,
Onions	100,805	,,
Rye	15,204	,,
Barley	14,166	,,
India tea	699	,,
Coconuts	236,327,000	
Beans	39,464	tons
Tomatoes	124,512	,,
Oranges	6,232,187	
Tobacco leaf	115,745	tons
Linseed	198,759	,,
Tung	11,977	,,
Grapes	226,079	,,

Compared with 1948, the figures for last year showed an increase in the following products: Pineapples, garlic, pea-nuts, barley, bananas, sweet potatoes, potatoes, cotton-seed, onions, rye, barley, Indian tea, coconuts, beans, oranges, tomatoes and grapes.

With regard to the principal products—cotton, rice, coffee, black beans, wheat, cocoa, mandioc, maize and sugar cane—sugar cane was the only crop which did not register a rise in production.

. . . but cocoa exports falling

Brazilian exports of cocoa have dropped considerably in the last few years. Her record year was 1941, when 132,944 tons were exported, as against 130,155 tons in 1939. Exports were at their lowest in 1948, with only 71,681 tons. In the first half of last year they were higher than in the same period of 1948 and totalled Cr.$269,531,000, but in spite of this the total for the whole of 1949 is expected to be less than in any of the years mentioned above. The cocoa trade has also undergone fluctuations in price. In 1948, for instance, though the amount exported was insignificant, it realised the greatest sum till then recorded, i.e. Cr.$1,065,884,000. The same anomaly occurred in 1947, when 99,041 tons brought in a total of Cr.$10,47,731,000. The United States purchased 73% of the total exported and the remaining 27% was sent to other foreign markets, with Argentina as the second greatest buyer, followed by England and the Benelux countries. Only a small quantity was sent to Germany, the greatest pre-war buyer of Brazilian cocoa, as she is only now resuming imports of this product. The price per ton has also varied considerably.

U.K. sugar imports and exports, 1949

Sugar imports into the United Kingdom last year showed an increase over those of 1948 of no less than 330,000 tons, only 60,000 tons of which were accounted for by an expansion in consumption, whilst 145,000 tons are represented in higher end-of-year stocks. Refined exports were slightly lower, but about 55,000 tons more raws passed through British refineries.

Foreign cane imports accounted for only 30,000 tons of this increase, whilst Commonwealth producers sent us over 300,000 tons more than in the previous year and no less than 630,000 tons more than in 1947. Australia nearly doubled her 1948 forwardings at 343,000 tons, whilst Mauritius added nearly 100,000 tons to her previous year's total. The British Caribbean area sent us about 25,000 tons more, whilst South Africa's resumed shipments brought us 43,000 tons.

It is of interest to note that the Commonwealth contribution is within 190,000 tons of the 1938 total. The record total received from the British Commonwealth was in 1937, when it reached 1,326,700 tons. In that year Canada reduced her imports in order to work off her excess stocks and B.W.I. sugars were diverted to the U.K. market, but increased shipments were general from all Commonwealth sources. It will be noticed that barely 68,000 tons were received from the Colonies in 1913. Then, of course, Empire sugars were not accorded a duty preference in the U.K. and most of the Mauritius crop found its way to India.

British refined exports again made a valuable contribution to the international trade of this country, but the total to foreign destinations was some 70,000 tons lower than in 1948. Switzerland took 34,000 tons less, whilst Greece and Turkey together received nearly 60,000 tons less than in 1948. More was shipped to Eire, France and Germany, whilst Portugal was a notable newcomer with over 10,000 tons to her credit. At 45,000 tons, more than double the 1948 tonnage was sent to Iraq, whilst Syria and Libya between them took 27,000 tons, against little more than 1,000 tons in 1948. Uruguay figures with 46,000 tons, following an absence since 1938 from this market.

To the Commonwealth areas shipments were 53,000 tons in excess of the 1948 total. Pakistan received 36,000 tons, as did also the Sudan, in both instances marking a substantial increase. British Malaya more than doubled her intake at 37,000 tons, but only 1,600 tons were shipped to South Africa, against 28,000 tons in 1948. The Persian Gulf received only 7,000 tons, compared with 24,000 tons.

Consumption as expressed by net withdrawals of imported sugar totalled 1,507,700 tons, whilst 540,000 tons domestic beet sugar were delivered to bring the total, expressed in raw value, to 2,047,700 tons, or some 87,000 tons more than in 1948.

Burma's edible oil production declines

Burma's plan for self-sufficiency in edible oils has been disrupted by post-war economic and political dislocations, spreading insurrection and some unfavourable weather conditions.

Sesame and groundnut crops, Burma's two principal vegetable oilseeds, not only are far below pre-war production levels, but are now being obtained in smaller quantities than during 1947.

The 1948 **sesame** crop of 45,800 short tons was almost 6% less than it had been the year before due to reduced plantings. A still smaller output, estimated at 36,300 tons, was harvested in 1949. Semi-drought conditions immediately after the sowing season reduced the yield per acre. Likewise, the 1948 **groundnut** crop of 161,300 tons was approximately 6% less than the previous year's harvest. The decrease was principally attributed to reduced planting and adverse weather conditions. The 1949 output probably did not exceed 143,400 tons, since the planted area was expected to be 9% less than it had been in the previous year, and the yield per acre was believed reduced by irregular distribution of rains.

The same is discernible in the case of vegetable oils. Officials estimate that vegetable oil production is slightly more than half the pre-war volume. Production during 1948-49 probably did not exceed 28,000 tons of groundnut oil and 11,000 tons of sesame oil, compared with the pre-war averages of 45,000 and 22,000 respectively.

Imports of vegetable oilseeds have virtually ceased since the war and the volume of vegetable oil imports has been lower than that of pre-war.

Since the war cottonseed has been the principal oilseed exported from Burma.

Reduced oilseed and oil supplies and heavy consumer demand have combined to raise the post-war prices far above pre-war levels. No appreciable change from 1948-49 is anticipated in the 1949-50 price level.